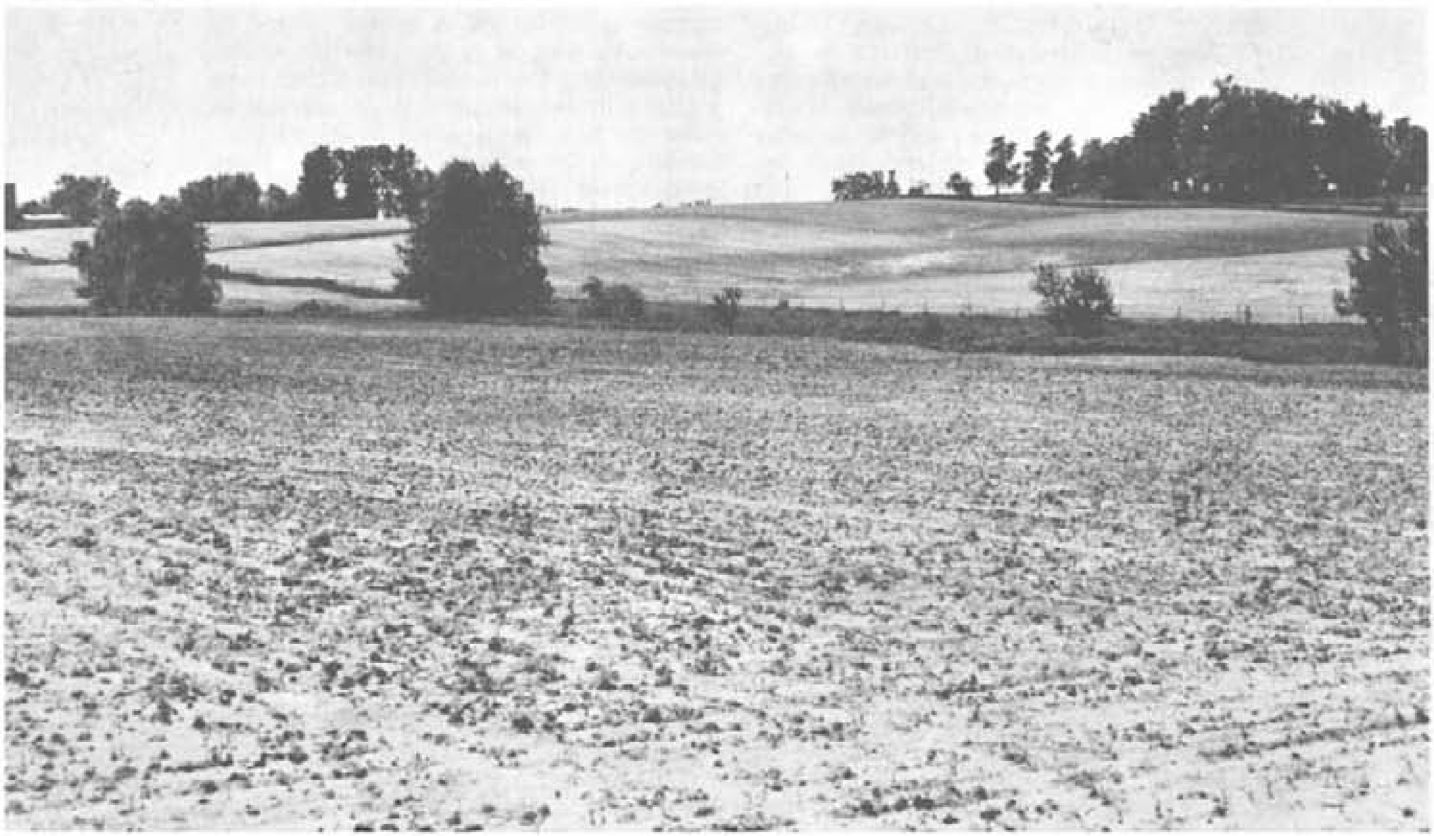
SOIL SURVEY OF

Linn County, Iowa



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Iowa Agriculture and Home Economics Experiment Station and
Cooperative Extension Service, Iowa State University
and the
Department of Soil Conservation, State of Iowa

Major fieldwork for this soil survey was done in the period 1962 to 1969. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1971. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service of Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Linn County Soil Conservation District.

Copies of the printed soil map can be made by commercial photographers, or can be purchased on individual order, from the Cartographic Division, Soil Conservation Service, United States Department of Agriculture, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Linn County contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Linn County are shown on the detailed map at the back of this survey. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with numbers shown on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by a symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey, This guide lists all of the soils of the county in numerical order by map symbol and gives the capability unit and woodland group for each soil. It shows the page where each kind of soil is described and also the page for the capability unit.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils in the soil descriptions and in the discussions of the interpretive groupings.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife."

Community planners and others concerned with suburban development can read about the soil properties that affect the choice of homesites, industrial sites, schools, and parks in the section "Nonfarm Uses of the Soils."

Engineers and builders will find under "Engineering Uses of the Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Linn County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "Additional Facts About the County."

Cover: **Typical topography in Kenyon-Clyde-Floyd association.**

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Contents

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SOIL SURVEY OF LINN COUNTY, IOWA[1]

BY EDWARD J. SCHERMERHORN AND JOHN D. HIGHLAND, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION AND COOPERATIVE EXTENSION SERVICE OF IOWA STATE UNIVERSITY, AND THE DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

LINN COUNTY is in the east-central part of Iowa (fig. 1). Cedar Rapids is the county seat and largest city. The county has an area of 458,752 acres. It is bounded on the north by Buchanan and Delaware Counties, on the east by Jones and Cedar Counties, on the south by Johnson County, and on the west by Benton County.

Farming is the main economic enterprise in Linn County, but industry and urbanization are increasing very rapidly in the vicinity of Cedar Rapids and Marion. The principal crops are corn, soybeans, oats, hay, and pasture. Except for soybeans, most of the crops are fed to livestock. Beef cattle, hogs, and dairying are the principal sources of income.

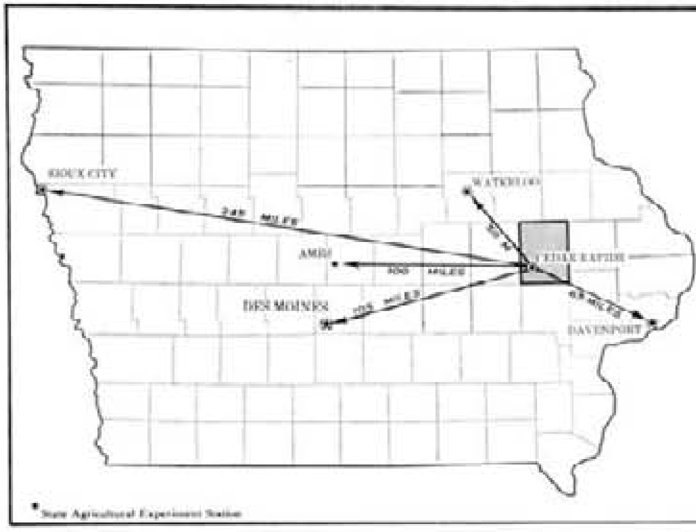

Figure 1.—Location of Linn County in Iowa.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Linn County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of this series was first observed and mapped. Tama and Fayette, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Fayette silt loam, 2 to 5 percent slopes, is one of several phases within the Fayette series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

[1] The soils were surveyed and the survey manuscript prepared under the general direction of LACY I. HARMON, Soil Conservation Service, and F. F. RIECKEN, Iowa Agriculture and Home Economics Experiment Station. Those participating in the fieldwork were W. L. FOUTS, W. D. FREDERICK, J. D. HIGHLAND, D. D. HOEFT, and E. J. SCHERMERHORN, Soil Conservation Service.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit is shown on the soil map of Linn County, the soil complex.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Colo-Ely complex, 2 to 5 percent slopes, is an example of a complex.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Loamy alluvial land is a land type in Linn County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soils in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultations. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Linn County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The nine soil associations in Linn County are discussed in the following pages.

1. Loamy alluvial land-Sparta-Spillville association

Nearly level to moderately sloping, dark-colored to light-colored, excessively drained to poorly drained soils formed in sandy and loamy material; on bottom lands and stream benches

This association consists mainly of nearly level to moderately sloping soils on bottom lands and stream benches, two distinct landforms that are impractical to separate in mapping. A few areas of strongly sloping to steep soils occur along the bench escarpments. The soils on bottom lands are subject to frequent flooding, but most soils on stream benches are generally free of flooding, except where they occur in some low areas or during very heavy rains. Away from the streams, the hazard of flooding on bench soils decreases as elevation increases, but in places these soils receive runoff from adjacent hillsides.

This association occupies about 18 percent of the county. About 22 percent is Loamy alluvial land, about 15 percent is Sparta soils, about 9 percent is Spillville soils, about 7 percent is Colo soils, and about 7 percent is Waukee soils. The remaining 40 percent is principally Atterberry soils, sandy substratum, and soils of the Chelsea, Dickinson, Lawler, Marshan, Nevin, Sattre, Wapsie, Waukegan, and Whittier series.

Loamy alluvial land is nearly level and well drained to poorly drained. It consists mainly of clayey to sandy material that was deposited by streams, but some areas have no subsoil formation and are commonly flooded. Water often remains ponded in the oxbows and remnants of former stream channels that dissect this land type. Some areas are undulating because of depressions or channels and natural levees that formed during periods of flooding.

Excessively drained Sparta soils are nearly level or gently sloping and are on broad ridges and escarpments. These soils formed in sand deposited by water and wind and have a thick, dark-colored, sandy surface layer underlain by a brown or yellowish-brown, sandy subsoil.

Spillville soils are at slightly higher elevations than some of the other bottom-land soils, but they are frequently flooded. They are moderately well drained to somewhat poorly drained and nearly level. These soils formed in loamy alluvium and have a thick, dark-colored loam surface layer.

Colo soils are poorly drained and are in depressions or drainageways. They are subject to frequent flooding.

Waukee soils are well-drained and nearly level to gently sloping. They are on terraces.

Farms and roads in this association commonly form irregular patterns; the shape of the fields is determined by the boundaries of the streams, old stream meanders, and oxbows. Farms are generally at the higher elevations, and the areas are not subject to flooding. Some roads parallel the rivers, but the network of roads is sketchy, and only a few roads cross the rivers.

The principal concerns of management are flood control, drainage improvement, erosion control, and maintenance of tilth and fertility. Potential productivity ranges from very low to high. Loamy alluvial land is used principally for pasture and woods. Sparta soils are used for cultivated crops, but they are not well suited to this purpose, even if management is good. Spillville soils are suited to row crops.

2. *Waukee-Dickinson association*

Nearly level to moderately sloping, well-drained and somewhat excessively drained, dark-colored soils formed in loamy material underlain by sand; on uplands

This association consists of nearly level to moderately sloping soils on uplands. The soils in this association formed in loamy or sandy material underlain by sand. Typical areas of this association are north and northwest of Whittier.

This association occupies about 1 percent of the county. About 40 percent is Waukee soils and about 16 percent is Dickinson soils. The remaining 44 percent is principally Clyde, Dinsdale, Flagler, Franklin, Hayfield, Kenyon, Saude, Sparta, and Waukegan soils.

Waukee soils are nearly level to gently sloping and are on broad ridges. They are well drained and have a thick, dark-colored loam surface layer. The subsoil is brown and is underlain by sand below a depth of about 3 feet. The Waukee soils in this association are underlain by glacial till at a depth of 8 feet to more than 20 feet.

Dickinson soils are well drained to somewhat excessively drained. These soils are gently sloping to moderately sloping on ridges and sides of ridges. They have a thick, dark-colored fine sandy loam surface layer over a dark-brown to dark yellowish-brown sandy loam subsoil.

Most areas of soils in this association are used for cultivated crops. The soils are suited or well suited to such crops. The principal concerns of management are control of erosion and maintenance of tilth and fertility.

3. *Kenyon-Clyde-Floyd association*

Nearly level to strongly sloping, dark-colored, moderately well drained to poorly drained soils formed in loamy material and glacial till; on uplands

The soils in this association are nearly level to strongly sloping. Low swells rise between intervening swales and result in a swell-and-swale topography in many areas of this association. The swales are connected to form a system of low-gradient drainageways through which water moves slowly. Rocks and boulders (fig. 2) are conspicuous landscape features in much of this area. This association has a rectangular pattern of fields and county roads. The roads generally follow section lines. The soils in this association formed in loamy material and glacial till (fig. 3).

This association occupies about 30 percent of the county. About 21 percent is Kenyon soils, about 14 percent is Clyde soils, about 7 percent is Floyd soils, about 6 percent is Dickinson soils, and about 6 percent is Aredale soils. The remaining 46 percent is principally Bassett, Bertram, Coggon, Dickinson, Oran, Readlyn, Schley, Sparta, Tripoli, and Waukee soils.

Kenyon soils are nearly level on ridgetops and strongly sloping on side slopes. These soils are moderately well drained and have a thick, dark-colored loam surface layer over a yellowish-brown subsoil that contains stones and pebbles.

Clyde soils are nearly level to gently sloping and are in drainageways and lower concave areas. These soils are poorly drained and have a thick, dark-colored silty clay loam surface layer over a gray, stratified subsoil that is mottled yellowish brown in the lower part. Many areas of these soils contain stones and boulders.

Floyd soils are generally nearly level to gently sloping and are in concave, downslope areas. They are somewhat poorly drained and have a thick, dark-colored loam surface layer over a loam subsoil that is mottled yellowish brown and contains stones and pebbles.

Dickinson soils are on low dunelike mounds or along drainageways. They are well drained to excessively drained.

Aredale soils generally are in convex areas. They are thick, dark-colored, well-drained, loamy soils underlain by loam till.

Almost all of this association is cultivated. It is well suited to cultivated crops. The principal concerns of management are improvement of drainage, control of erosion (fig. 4), and maintenance of tilth and fertility. Uncultivated areas of this association are steep, sandy, wet, or rocky, and they commonly occur along streams. Some wet areas remain undrained because of many glacial boulders. Wetness, caused in part by hillside seepage, is a limitation to use of Clyde, Floyd, and Schley soils. In these areas, interceptor tile laid upslope from the wet spots is needed for drainage.

4. *Readlyn-Oran-Tripoli association*

Nearly level, dark colored to moderately dark colored, somewhat poorly drained and poorly drained soils formed in loamy material and glacial till; on uplands

This association consists mainly of nearly level soils on broad upland flats that have a few distinct drainageways. The soils in this association formed in loamy material and glacial till. Drainage is somewhat poor to poor. This association has a rectangular pattern of fields and county roads. The roads generally follow section lines. Typical areas of this association are north and northwest of Alburnett.

This soil association occupies about 3 percent of the county. About 30 percent is Readlyn soils, about 29 percent Oran soils, and about 16 percent Tripoli soils. The remaining 25 percent is Aredale, Bassett, Clyde, Dickinson, Donnan, Floyd, Kenyon, Schley, and Sparta soils.

Figure 2.—Typical area in Kenyon-Clyde-Floyd association.

Readlyn soils are in broad or slightly convex areas. They are somewhat poorly drained and have a thick, dark-colored loam surface layer. The subsoil is grayish-brown and yellowish-brown, mottled loam till. Oran soils are generally in broad or slightly concave areas along drainageways and in large, ponded areas. These soils are somewhat poorly drained and have a relatively thin, moderately dark colored loam surface layer over a dark grayish-brown subsurface layer. The subsoil is grayish-brown and yellowish-brown, mottled loam till.

Tripoli soils are in broad or slightly concave areas along drainageways and in large, ponded areas. These soils are poorly drained and have a thick, dark-colored silty clay loam surface layer underlain by grayish-brown and yellowish-brown loam till.

Almost all of this association is used for cultivated crops, and only a few areas are in permanent pasture. This association is well suited to cultivated crops. Although much of this area has been drained, improvement of drainage is still the principal concern of management. Rocks or boulders interfere with cultivation and tile drainage in places. Maintenance of tilth and fertility is also a management concern.

5. *Kenyon-Dinsdale association*

Gently sloping to strongly sloping, dark-colored, well drained and moderately well drained soils formed in loamy material and glacial till or in silty material and glacial till; on uplands

The soils in this association are well drained and moderately well drained. They formed in loamy material and glacial till or in silty material and glacial till (fig. 5). The areas are undulating and have distinct drainageways and very few depressions where shallow ponds can form. The low, smooth, rounded slopes give this association a topography that is distinctly different from that of the rest of the county. The borders of this association are hilly and strongly dissected. The fields and county roads are in a rectangular pattern. The roads generally follow section lines.

This association occupies about 13 percent of the county. About 34 percent is Kenyon soils, and about 26 percent is Dinsdale soils. About 6 percent is Klinger and Maxfield soils that are closely intermingled. The remaining 34 percent is Bassett, Clyde, Colo, Donnan, Ely, Franklin, Tama, Walford, Waubeek, Waukee, and Waukegan soils. Outcrops of limestone occur in several areas of this association.

The Kenyon soils are gently sloping on ridges and strongly sloping on sides of ridges. Kenyon soils are moderately well drained and have a thick, dark-colored loam surface layer over a yellowish-brown loam subsoil that contains stones and pebbles.

The Dinsdale soils are gently sloping on ridgetops and moderately sloping on sides of ridges. Dinsdale soils are well drained to moderately well drained and have a dark-colored silty clay loam surface layer. The subsoil is brown or yellowish-brown silty clay loam over yellowish-brown loam glacial till that contains some stones and pebbles.

Almost all areas of the soils in this association are used for cultivated crops. Permanent pastures are confined mainly to the poorly drained swales and water-

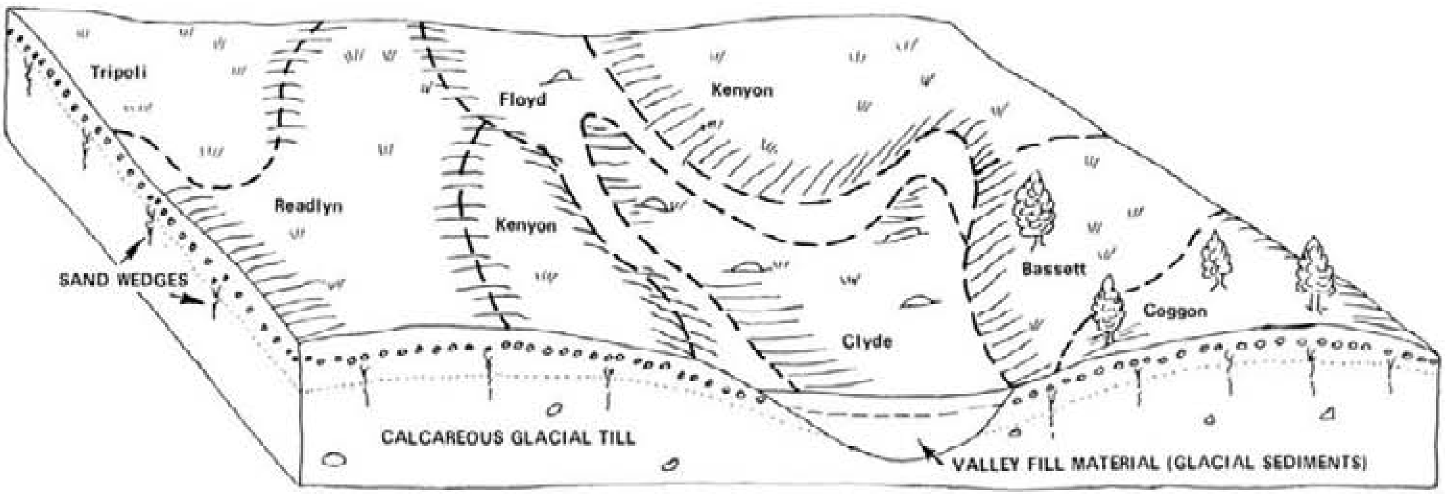

Figure 3.—Topography, soils, and underlying materials in association 3.

ways. The principal concerns of management are control of water erosion, improvement of drainage, and maintenance of tilth and fertility.

6. *Dinsdale-Klinger association*

Nearly level to moderately sloping, dark-colored, well-drained to somewhat poorly drained soils formed in silty material and glacial till; on uplands

This association consists mainly of nearly level and gently sloping soils on convex ridges, and moderately sloping soils on sides of ridges. These soils are well drained to somewhat poorly drained. They formed in loess and glacial till; the loess is 24 to 40 inches thick. This association has a rectangular pattern of fields, and county roads commonly follow section lines. Typical areas of this association are east of Marion and 2 miles north of Mount Vernon.

This association occupies about 8 percent of the county. About 41 percent is Dinsdale soils, and about 19 percent is Klinger soils. The remaining 40 percent is principally Aredale, Clyde, Colo, Ely, Franklin, Garwin, Judson, Kenyon, Maxfield, Muscatine, Tama, and Waukegan soils. Outcrops of limestone are on the surface in several parts of this association.

The Dinsdale soils are gently sloping on ridgetops and moderately sloping on sides of ridges. Dinsdale soils are well drained or moderately well drained and have a thick, dark-colored silty clay loam surface layer. The subsoil is brown or yellowish-brown silty clay loam underlain by yellowish-brown loam glacial till that contains some stones and pebbles.

Klinger soils are nearly level and are on flats or in slightly concave downslope areas. These soils are somewhat poorly drained and have a thick, dark-colored silty clay loam surface layer. The subsoil is grayish-brown silty clay loam underlain by grayish-brown and yellowish-brown loam glacial till that contains some stones and pebbles.

Almost all the acreage of the soils in this association is used for cultivated crops. Potential production is high. The main concerns of management are control of water erosion, improvement of drainage, and maintenance of tilth and fertility.

7. *Klinger-Franklin-Maxfield association*

Nearly level, dark colored to moderately dark colored, somewhat poorly drained and poorly drained soils formed in silty material and glacial till; on uplands

This association consists of nearly level soils on broad flats that have a few distinct drainageways. These soils are somewhat poorly drained and poorly drained. They formed in loess and glacial till; the loess is 24 to 40 inches thick.

This association has a rectangular pattern of fields and county roads. The roads generally follow section lines. Typical areas of this association are east or south of Alburnett.

This association occupies about 4 percent of the county. About 30 percent is Klinger soils, about 30 percent is Franklin soils, and about 15 percent is Maxfield soils. The remaining 25 percent is Aredale, Clyde, Dickinson, Dinsdale, Donnan, and Kenyon soils.

The Klinger soils are nearly level and are on flats and lower sides of the few gently sloping ridges. These soils are somewhat poorly drained and have a thick, dark-colored silty clay loam surface layer over a grayish-brown, mottled silty clay loam subsoil underlain by grayish-brown and yellowish-brown loam glacial till.

The Franklin soils are nearly level and are on divides and in concave areas at the head of drainageways. These soils are somewhat poorly drained and have a relatively thin, dark-colored silt loam surface layer over a grayish-brown silt loam subsurface layer. The subsoil is grayish-brown, mottled silty clay loam underlain by grayish-brown and yellowish-brown loam glacial till.

Maxfield soils are in slight depressions on upland flats or at the head of broad, shallow drainageways. These soils are poorly drained and have a thick, dark-colored silty clay loam surface layer. The subsoil is gray to olive-gray, mottled silty clay loam underlain by yellowish-brown, mottled loam glacial till.

Figure 4.—Contour stripcropping on Kenyon loam, 5 to 9 percent slopes.

Almost all the acreage of the soils in this association is used for cultivated crops, and the soils are well suited to this use. Improvement of drainage is the principal concern of management. Maintenance of tilth and fertility is also a concern.

8. *Tama-Colo-Ely association*

Nearly level to moderately sloping, dark-colored, well-drained, somewhat poorly drained, and poorly drained soils formed in silty material; on uplands and in upland drainageways

This association consists of nearly level to gently sloping soils on ridgetops and of moderately sloping soils on side slopes. The soils in this association (fig. 6) formed in loess or silty material that is more than 40 inches thick. This association has a rectangular pattern of fields and roads. The roads generally follow section lines. The largest area of this association is north and east of Mount Vernon.

This soil association occupies about 3 percent of the county. About 37 percent is Tama soils, 11 percent is Colo and Ely soils that are closely intermingled, 4 percent is Atterberry soils, and 2 percent is Muscatine soils. The remaining 46 percent is principally Dickinson, Dinsdale, Dodgeville, Downs, Garwin, Judson, Kenyon, Rockton, Sparta, Walford, and Waukegan soils.

Tama soils are nearly level in broad, flat areas, and moderately sloping on side slopes. Tama soils are well-drained and have a thick, dark-colored silty clay loam surface layer over a dark-brown to yellowish-brown silty

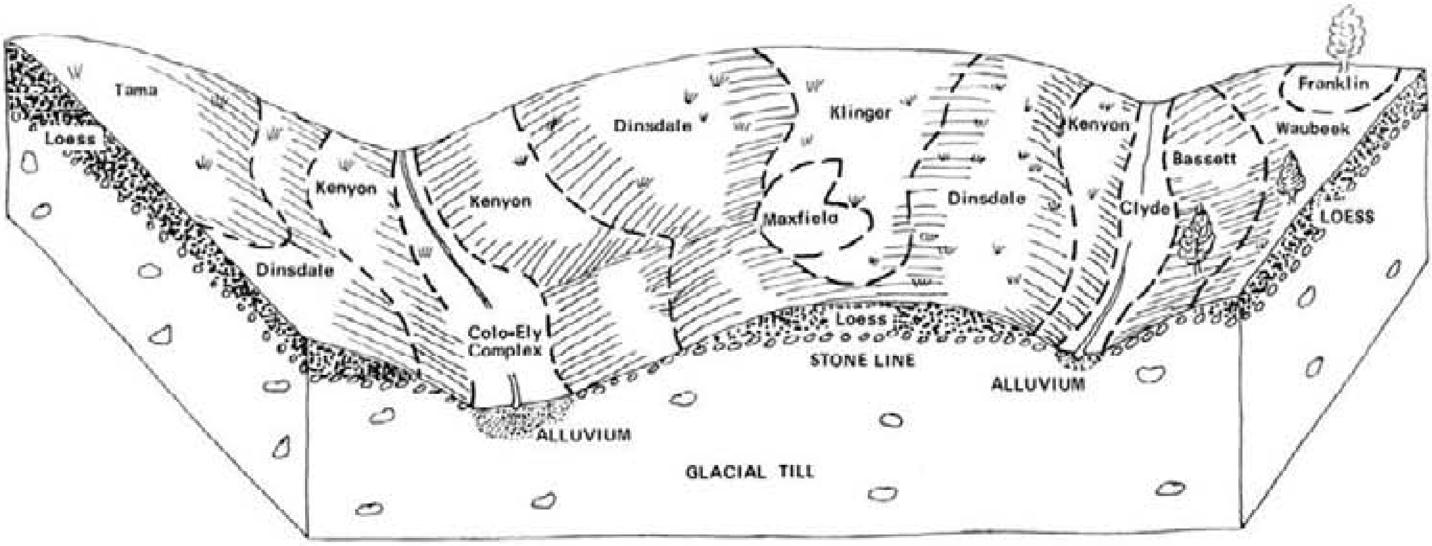

Figure 5.—Topography, soils, and underlying materials in association 5.

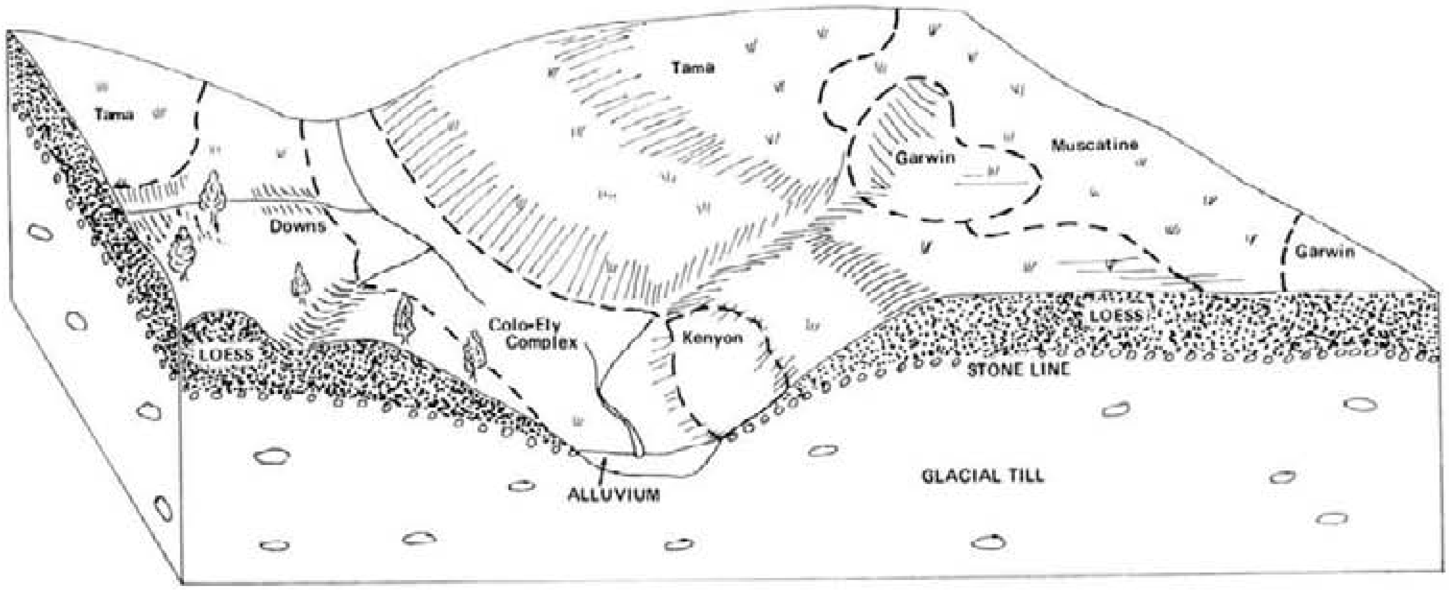

Figure 6.—**Topography, soils, and underlying materials in association 8.**

clay loam subsoil that grades to silt loam as depth increases.

Colo soils are near the center of drainageways, and Ely soils are at the base of steeper slopes on uplands. Colo soils are poorly drained and have a thick, dark-colored silty clay loam surface layer. The substratum is olive-gray, mottled silty clay loam. Ely soils are somewhat poorly drained and have a thick, dark-colored silt loam surface layer. The subsoil is grayish-brown, mottled silty clay loam that grades to yellowish-brown and grayish-brown, mottled light silty clay loam.

Atterberry soils are nearly level or gently sloping and are on upland divides, at the head of drainageways, and at the base of slopes. These soils are somewhat poorly drained and have a relatively thin, dark-colored silt loam surface layer over a lighter colored subsurface layer. The subsoil is grayish-brown silty clay loam and yellowish-brown and gray, mottled silty clay loam and silt loam.

Muscatine soils are nearly level and are on upland divides and in depressions at the head of upland drainageways. These soils are somewhat poorly drained and have a thick, dark-colored silty clay loam and silt loam surface layer. The subsoil is grayish-brown, mottled silty clay loam.

Almost all of the acreage of these soils is in cultivation, but a small acreage is used for permanent pasture. The principal concerns of management are control of water erosion, improvement of drainage, and maintenance of tilth and fertility. The slopes are long and uniform and are suitable for contouring and terracing.

9. Fayette-Downs-Chelsea association

Gently sloping to very steep, light-colored to moderately dark colored, well-drained and excessively drained soils formed in silty and sandy material; on uplands

This association consists mainly of gently sloping soils on ridgetops to very steep soils in areas that are dissected by side-valley waterways (fig. 7). The soils in this association formed in loess or sand that is more than 40 inches thick. The largest area of this association is southeast of Cedar Rapids, and nearly all areas are adjacent to the Cedar and Wapsipinicon Rivers and Buffalo Creek. Outcrops of limestone are on the surface in many areas, especially adjacent to major streams (fig. 8). Also in this association is a series of gently sloping to very steep, dome-shaped hills called pahas. They tend to be oriented in a northwest-southeast direction. In places they are on both sides of the larger streams, but many of them are located miles from any river. One series of pahas is north of Alburnett. These hills are rather prominent because of the nearly level to gently sloping topography that surrounds them.

This association occupies about 20 percent of the county. About 44 percent is Fayette soils, about 16 percent is Downs soils, and about 12 percent is Chelsea soils. The remaining 28 percent is principally Bassett, Nodaway, Seaton, and Sogn soils; Steep rock land; and Chelsea, Lamont, and Fayette soils that are closely intermingled.

Fayette soils are on rounded ridges and side slopes. These soils are well drained, and in cultivated areas they have a light-colored silt loam surface layer. The subsoil is dark yellowish-brown silty clay loam that grades to silt loam as depth increases.

Downs soils are generally more gently sloping than Fayette soils and are on ridges and side slopes. These soils are well drained and have a moderately thick, moderately dark-colored silt loam surface layer over a lighter-colored silt loam subsurface layer. The subsoil is dark yellowish-brown silty clay loam that grades to silt loam as depth increases.

The Chelsea soils are nearly level to gently sloping on ridges on uplands and strongly sloping to very steep on side slopes. These soils are excessively drained and

Figure 7.—County park in Fayette-Downs-Chelsea association.

have a light-colored loamy fine sand surface layer over yellowish-brown fine sand.

The farms in this association are mostly on ridgetops, although a few are in small valleys. The fields are commonly small and have a variety of shapes. County roads seldom follow section lines. Trees are along roads, fence lines, and drainageways, in coves, and around farms. There are stands of oak and hickory remaining from the native vegetation, and these are a distinctive feature of the landscape. A large acreage of this association is in woods and permanent pasture.

The principal concerns of management are control of erosion and maintenance of tilth and fertility. Many farmers cultivate soils on ridgetops and in valleys, and management is more difficult in these areas than on farms where soils and slopes are more uniform. The silty soils have high potential productivity, but they are subject to erosion and in places are too steep for cultivated crops. The sandy soils, which are also subject to erosion and are too steep for cultivated crops in places, have low potential productivity because they are droughty.

Descriptions of the Soils

This section describes the soil series and mapping units in Linn County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit. Color terms are for moist soil unless otherwise stated.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Loamy alluvial land and Marsh, for example, do not belong to a soil series, but nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and woodland suitability group in which the mapping unit has been placed. The page for the description of each capability unit and the woodland suitability group can be learned by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary, and more detailed information about the terminology and

Figure 8.—An area of Steep rock land and limestone outcrops along Cedar River in Fayette-Downs-Chelsea association.

methods of soil mapping can be obtained from the Soil Survey Manual (*14*).[2]

Aredale Series

The Aredale series consists of well-drained soils that formed in loamy material and loam glacial till. Depth to loamy material is about 42 to 60 inches. These soils have convex slopes and are on uplands. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark and very dark grayish-brown loam about 19 inches thick. The subsoil is about 51 inches thick. The upper 14 inches is brown and dark yellowish-brown, friable light clay loam and heavy loam. The next 22 inches is yellowish-brown sandy loam. The lower 15 inches is yellowish-brown heavy loam that has grayish mottles.

Aredale soils have moderate permeability and high available water capacity. These soils are low to medium in available nitrogen and potassium and very low in available phosphorus. They are acid where they have not been limed within the last 5 years.

These soils are well suited to cultivated crops.

Representative profile of Aredale loam, 2 to 5 percent slopes, in a cultivated field, 352 feet north and 651 feet east of the southwest corner of SW¼NW¼ sec. 20, T. 85 N., R. 6 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; cloddy, breaking to moderate, fine, granular structure; medium acid; abrupt boundary.

A12—7 to 14 inches, very dark brown (10YR 2/2) loam; moderate, fine, granular structure; friable; medium acid; gradual boundary.

A3—14 to 19 inches, very dark grayish-brown (10YR 3/2) and dark-brown (10YR 3/3) loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21—19 to 26 inches, brown (10YR 4/3) light clay loam; weak, medium, subangular blocky structure; friable; strongly acid; gradual boundary.

B22—26 to 33 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, medium, subangular blocky structure; friable; strongly acid; gradual boundary.

IIB31—33 to 55 inches, yellowish-brown (10YR 5/4) sandy loam; weak, coarse, subangular blocky structure; friable; few, fine, faint, grayish-brown (10YR 5/2) mottles; medium acid; gradual boundary.

IIIB32—55 to 70 inches, yellowish-brown (10YR 5/6) heavy loam, brown (10YR 5/3) crushed; common, fine, distinct, gray (10YR 6/1) and light brownish-gray (10YR 6/2) mottles; weak, coarse, prismatic structure; firm; medium acid.

The solum is commonly 48 inches or more in thickness and formed in loamy sediment that is free of stones and gravel. Depth to fine loamy glacial till ranges from about 42 to 60 inches. A coarser textured layer as much as 24 inches thick, is between the loamy glacial sediment and the glacial till in many places. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon is loam or silt loam that contains enough sand to have a gritty feel. The B2 horizon has a hue of 10YR, a value of 3 to 5, and a chroma of 3 to 6. It is free of low-chroma mottles to a depth of about 36 inches. The B2 horizon ranges from loam to light clay loam or light sandy clay loam. Thickness of the IIB3 horizon varies widely within short distances. In places the IIB3 horizon is loamy sand, but it typically is sandy loam that contains some stones and pebbles. Reaction ranges from medium acid to strongly acid in the most acid part of the solum.

[2] Italic numbers in parentheses refer to Literature Cited, p. 147.

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Acres	Percent
Aredale loam, 0 to 2 percent slopes	470	0.1
Aredale loam, 2 to 5 percent slopes	10,225	2.2
Aredale loam, 5 to 9 percent slopes	2,650	.6
Atterberry silt loam, 0 to 2 percent slopes	1,400	.3
Atterberry silt loam, 2 to 5 percent slopes	405	.1
Atterberry silt loam, benches, 0 to 2 percent slopes	1,700	.4
Atterberry silt loam, sandy substratum, 0 to 2 percent slopes	3,640	.8
Bassett loam, 2 to 5 percent slopes	1,365	.3
Bassett loam, 5 to 9 percent slopes	495	.1
Bassett loam, 5 to 9 percent slopes, moderately eroded	1,410	.3
Bassett loam, 9 to 14 percent slopes, moderately eroded	935	.2
Bassett loam, 14 to 18 percent slopes, moderately eroded	170	(1)
Bassett loam, 18 to 30 percent slopes, moderately eroded	105	(1)
Bertram sandy loam, 2 to 5 percent slopes	435	.1
Bertram sandy loam, 5 to 9 percent slopes	885	.2
Bertrand silt loam, 0 to 2 percent slopes	395	.1
Bertrand silt loam, 2 to 5 percent slopes	415	.1
Burkhardt sandy loam, 2 to 9 percent slopes	380	.1
Burkhardt sandy loam, 9 to 14 percent slopes, moderately eroded	570	.1
Chelsea loamy fine sand, 0 to 2 percent slopes	415	.1
Chelsea loamy fine sand, 2 to 5 percent slopes	1,395	.3
Chelsea loamy fine sand, 5 to 9 percent slopes	3,540	.8
Chelsea loamy fine sand, 9 to 18 percent slopes	3,270	.7
Chelsea loamy fine sand, 18 to 30 percent slopes	810	.2
Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes	1,390	.3
Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes, moderately eroded	1,140	.2
Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes	2,389	.5
Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes, moderately eroded	5,026	1.1
Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes	2,365	.5
Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes, moderately eroded	1,460	.3
Clyde silty clay loam	18,661	4.1
Clyde-Floyd-Schley complex, 1 to 4 percent slopes	10,815	2.4
Coggon loam, 5 to 9 percent slopes, moderately eroded	275	.1
Colo silt loam, overwash	995	.2
Colo silty clay loam	10,095	2.2
Colo-Ely complex, 2 to 5 percent slopes	6,740	1.5
Dickinson fine sandy loam, 0 to 2 percent slopes	2,325	.5
Dickinson fine sandy loam, 2 to 5 percent slopes	6,375	1.4
Dickinson fine sandy loam, 5 to 9 percent slopes	2,370	.5
Dickinson finesandy loam, 9 to 14 percent slopes	375	.1
Dickinson fine sandy loam, loam substratum, 2 to 5 percent slopes	7,100	1.6
Dickinson fine sandy loam, loam substratum, 5 to 9 percent slopes	5,105	1.1
Dickinson-Sparta-Tama complex, 5 to 9 percent slopes	270	.1
Dickinson-Sparta-Tama complex, 9 to 14 percent slopes	310	.1
Dinsdale silty clay loam, 2 to 5 percent slopes	25,878	5.6
Dinsdale silty clay loam, 5 to 9 percent slopes	4,230	.9
Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded	2,280	.5
Dodgeville silt loam, deep, 2 to 5 percent slopes	220	(1)
Dodgeville silt loam, deep, 5 to 9 percent slopes	170	(1)
Donnan loam, 2 to 5 percent slopes	545	.1
Donnan loam, 5 to 9 percent slopes, moderately eroded	345	.1
Donnan loam, gray subsoil variant	665	.1
Downs silt loam, 2 to 5 percent slopes	1,555	.3
Downs silt loam, 5 to 9 percent slopes	1,245	.3
Downs silt loam, 5 to 9 percent slopes, moderately eroded	1,815	.4
Downs silt loam, 9 to 14 percent slopes	435	1
Downs silt loam, 9 to 14 percent slopes, moderately eroded	1,930	.4
Ely silt loam, 2 to 5 percent slopes	565	.1
Fayette silt loam, 2 to 5 percent slopes	1,890	.4
Fayette silt loam, 5 to 9 percent slopes	2,838	.6
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	6,150	1.3
Fayette silt loam, 9 to 14 percent slopes	1,970	.4
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	4,890	1.1
Fayette silt loam, 9 to 14 percent slopes, severely eroded	2,465	.5
Fayette silt loam, 14 to 18 percent slopes	1,140	.2
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	2,575	.6
Fayette silt loam, 14 to 18 percent slopes, severely eroded	1,900	.4
Fayette silt loam, 18 to 30 percent slopes	6,905	1.5
Fayette silt loam, 18 to 30 percent slopes, moderately eroded	4,415	1.0
Fayette silt loam, benches, 2 to 5 percent slopes	495	.1
Flagler sandy loam, 0 to 2 percent slopes	770	.2
Flagler sandy loam, 2 to 5 percent slopes	1,390	.3
Flagler sandy loam, 5 to 9 percent slopes	1,185	.3
Flagler sandy loam, 5 to 9 percent slopes, moderately eroded	310	.1
Floyd loam, 1 to 4 percent slopes	10,000	2.2
Franklin silt loam, 0 to 2 percent slopes	7,930	1.7
Franklin silt loam, 2 to 5 percent slopes	1,985	.4
Garwin silty clay loam	580	.1
Hayfield loam, deep	3,350	.7
Hayfield loam, moderately deep	1,255	.3
Judson silty clay loam, 2 to 5 percent slopes	2,980	.6
Kennebec silt loam	635	.1
Kenyon loam, 2 to 5 percent slopes	28,053	6.1
Kenyon loam, 5 to 9 percent slopes	13,103	2.9
Kenyon loam, 5 to 9 percent slopes, moderately eroded	9,150	2.0
Kenyon loam, 9 to 14 percent slopes, moderately eroded	710	.1
Klinger silty clay loam, 0 to 2 percent slopes	8,274	1.8
Klinger-Maxfield silty clay loams, 2 to 5 percent slopes	8,040	1.8
Lamont fine sandy loam, 2 to 5 percent slopes	1,395	.3
Lamont fine sandy loam, 5 to 9 percent slopes	900	.2
Lawler loam, deep	3,985	.9
Lawler loam, moderately deep	665	.1
Lawson silt loam	670	.1
Loamy alluvial land	17,535	3.8
Loamy terrace escarpments, 14 to 30 percent slopes	305	.1
Marsh	380	.1
Marshan silty clay loam, deep	5,710	1.2
Marshan silty clay loam, moderately deep	365	.1
Maxfield silty clay loam	3,985	.9
Muck, shallow	350	.1
Muck, moderately shallow	320	.1
Muscatine silty clay loam, 1 to 3 percent slopes	1,055	.2
Muscatine silty clay loam, benches, 0 to 2 percent slopes	570	.1
Nevin silty clay loam	885	.2
Nodaway silt loam, 0 to 2 percent slopes	2,185	.5
Nodaway silt loam, 2 to 5 percent slopes	2,365	.5
Olin fine sandy loam, 2 to 5 percent slopes	1,685	.4
Olin fine sandy loam, 5 to 9 percent slopes	2,010	.4
Oran loam, 0 to 2 percent slopes	4,340	1.0
Oran loam, 2 to 5 percent slopes	950	.2
Readlyn loam, 0 to 2 percent slopes	4,945	1.1

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of soils*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Richwood silt loam	1,295	.3	Tama silty clay loam, 2 to 5 percent slopes	6,135	1.3
Rockton loam, deep, 2 to 5 percent slopes	535	.1	Tama silty clay loam, 5 to 9 percent slopes	2,640	.6
Rockton loam, deep, 5 to 9 percent slopes	270	.1	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	660	.1
Rockton loam, moderately deep, 2 to 5 percent slopes	265	.1	Tama silty clay loam, benches, 0 to 2 percent slopes	610	.1
Rockton loam, moderately deep, 5 to 9 percent slopes	625	.1	Tama silty clay loam, benches, 2 to 5 percent slopes	795	.2
Rockton loam, moderately deep, 9 to 14 percent slopes	255	.1	Tell silt loam, 2 to 5 percent slopes	820	.2
Sattre loam, 0 to 2 percent slopes	795	.2	Tell silt loam, 5 to 9 percent slopes, moderately eroded	265	.1
Sattre loam, 2 to 5 percent slopes	1,375	.3	Tripoli silty clay loam	2,970	.7
Sattre loam, 5 to 9 percent slopes, moderately eroded	375	.1	Walford silt loam	275	.1
Saude loam, 0 to 2 percent slopes	2,030	.4	Walford silt loam, benches	975	.2
Saude loam, 2 to 5 percent slopes	1,490	.3	Wapsie loam, 0 to 2 percent slopes	835	.2
Saude loam, 5 to 9 percent slopes	750	.2	Wapsie loam, 2 to 5 percent slopes	630	.1
Schley loam, 1 to 4 percent slopes	1,900	.4	Waubeek silt loam, 2 to 5 percent slopes	975	.2
Seaton silt loam, 9 to 14 percent slopes	345	.1	Waubeek silt loam, 5 to 9 percent slopes, moderately eroded	335	.1
Seaton silt loam, 9 to 14 percent slopes, moderately eroded	520	.1	Waukee loam, 0 to 2 percent slopes	4,570	1.0
Seaton silt loam, 14 to 18 percent slopes	220	(1)	Waukee loam, 2 to 5 percent slopes	3,460	.8
Seaton silt loam, 14 to 18 percent slopes, moderately eroded	1,375	.3	Waukee loam, uplands, 0 to 2 percent slopes	330	.1
Seaton silt loam, 18 to 30 percent slopes	495	.1	Waukee loam, uplands, 2 to 5 percent slopes	2,385	.5
Seaton silt loam, 18 to 30 percent slopes, moderately eroded	290	.1	Waukee loam, uplands, 5 to 9 percent slopes	225	(1)
Sogn loam, 5 to 9 percent slopes	340	.1	Waukegan silt loam, 0 to 2 percent slopes	1,920	.4
Sogn loam, 9 to 18 percent slopes	1,100	.2	Waukegan silt loam, 2 to 5 percent slopes	1,980	.4
Sogn loam, 18 to 30 percent slopes	905	.2	Waukegan silt loam, 5 to 9 percent slopes	275	.1
Sparta loamy fine sand, 0 to 2 percent slopes	2,385	.5	Whalan loam, moderately deep, 5 to 9 percent slopes, moderately eroded	165	(1)
Sparta loamy fine sand, 2 to 5 percent slopes	7,510	1.6	Whittier silt loam, 0 to 2 percent slopes	340	.1
Sparta loamy fine sand, 5 to 9 percent slopes	6,050	1.3	Whittier silt loam, 2 to 5 percent slopes	920	.2
Sparta loamy fine sand, 9 to 18 percent slopes	1,205	.3	Whittier silt loam, 5 to 9 percent slopes, moderately eroded	320	.1
Sparta loamy fine sand, loam substratum, 2 to 5 percent slopes	2,440	.5	Limestone quarries	355	.1
Sparta loamy fine sand, loam substratum, 5 to 9 percent slopes	2,595	.6	Water	1,890	.4
Spillville loam	7,365	1.6	Sand and gravel pits	90	(1)
Steep rock land	465	.1	Borrow areas	135	(1)
Stronghurst silt loam, 0 to 2 percent slopes	235	.1	Made land	520	.1
Tama silty clay loam, 0 to 2 percent slopes	315	.1	Urban and built-up areas	12,010	2.6
			Total	458,752	100.0

[1] Less than 0.05 percent.

Aredale soils are associated with Dickinson, Dinsdale, and Kenyon soils. They contain more sand in the upper part of the solum than Dinsdale soils but less sand than Dickinson soils. They differ from Kenyon soils by having overlying material that is deeper over till and a thick sandy layer between the loamy overburden and the firm glacial till.

Aredale loam, 0 to 2 percent slopes (426A).—This soil is on uplands. It is commonly associated with Kenyon soils. This soil has a profile similar to the one described as representative for the series, but it has a thicker, dark surface layer and is underlain by limestone at a depth of 6 to 10 feet.

This soil is well suited to row crops and has no major limitations to management. It is suited to intensive production of corn and soybeans. Runoff is slight, because this soil is nearly level and has a high infiltration rate. Capability unit I–1; woodland suitability group 6.

Aredale loam, 2 to 5 percent slopes (426B).—This soil is on uplands. It is associated with Dickinson, Dinsdale, and Kenyon soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of soils where the depth to glacial till is more than 5 feet. Also included are a few areas of sandy soils that are droughty and less productive than this Aredale soil. These areas are indicated on the soil map by a special spot symbol.

This soil is well suited to row crops if it is properly managed. But if this soil is cultivated, it is subject to slight erosion. Cuts for terraces should be minimized to avoid exposing the less productive subsoil. Capability unit IIe–1; woodland suitability group 6.

Aredale loam, 5 to 9 percent slopes (426C).—This soil is on short, convex side slopes on uplands. It is commonly associated with Dickinson, Dinsdale, and Kenyon soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner.

Included with this soil in mapping are areas of strongly sloping soils where the hazard of erosion is more severe than on this Aredale soil. These soils have a thinner, lighter colored plow layer and a lower content of organic matter than this soil. Also included are a few areas of sandy soils that are droughty and less productive than this soil. These areas are indicated on the soil map by a special spot symbol.

This soil is suited to row crops if it is well managed. It is subject to erosion if it is cultivated. Cuts for ter-

races should be minimized to avoid exposing the less productive subsoil. Capability unit IIIe-1; woodland suitability group 6.

Atterberry Series

The Atterberry series consists of somewhat poorly drained soils that formed in loess. These soils are nearly level to gently sloping and are on upland divides, at the head of drainageways, at the base of slopes, and on loess-covered benches along major streams. They formed under mixed prairie and forest vegetation.

In a representative profile the plow layer is very dark gray silt loam about 9 inches thick. The subsurface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil extends to a depth of about 60 inches. It is dark grayish-brown, grayish-brown, yellowish-brown and gray silty clay loam in the upper part and grades to yellowish-brown and gray, mottled silt loam in the lower part.

Atterberry soils have moderate or moderately slow permeability and high available water capacity. These soils are low in available nitrogen and phosphorus and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops. Because the water table is moderately high, tile drainage is needed in places.

Representative profile of Atterberry silt loam, 0 to 2 percent slopes, in a cultivated field, 830 feet west and 385 feet north of the southeast corner of SW¼SE¼ sec. 1, T. 82 N., R. 5 W.:

Ap—0 to 9 inches, very dark gray (10YR 3/1) silt loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; clear boundary.

A2—9 to 16 inches, dark grayish-brown (10YR 4/2) silt loam; weak, thin, platy structure; friable; few, discontinuous, very dark grayish-brown (10YR 3/2) coatings on peds; few, fine, brown (7.5YR 4/4) oxide concretions; medium acid; clear boundary.

B1—16 to 24 inches, dark grayish-brown (10YR 4/2) light silty clay loam; grayish-brown (10YR 5/2) ped exteriors; many, fine, prominent yellowish-brown (10YR 5/6) mottles; moderate, fine, subangular blocky structure; friable; few, thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; few dark reddish-brown (5YR 2/2) oxide concretions; strongly acid; gradual boundary.

B21t—24 to 34 inches, grayish-brown (10YR 5/2) medium silty clay loam; many, fine and medium, prominent, yellowish-brown (10YR 5/6) mottles; moderate, fine and medium, subangular blocky structure; friable; few, thin, discontinuous clay films on faces of peds and in old root channels; nearly continuous, light brownish-gray (10YR 6/2, dry), grainy coatings; common dark reddish-brown (5YR 2/2) oxide concretions; medium acid; gradual boundary.

B22t—34 to 46 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 5/1) light silty clay loam; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; friable; thin, discontinuous, very dark gray (10YR 3/1) clay films on faces of peds and in old root channels; few, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; many dark reddish-brown (5YR 2/2) oxide concretions; medium acid; gradual boundary.

B3—46 to 60 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 5/1) heavy silt loam; weak, medium, prismatic structure; friable; thin, discontinuous, very dark gray (10YR 3/1) clay films on faces of peds and in old root channels; many dark reddish-brown (5YR 2/2) and brown (7.5YR 4/4) oxide concretions; 1-inch strata of sandy loam at a depth of 55 inches; medium acid.

The solum ranges from 40 to 60 inches or more in thickness. The A1 or Ap horizon ranges from 6 to 10 inches in thickness. It is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon is 3 to 8 inches thick. The B2 horizon has a hue of 10YR, 2.5Y, or 5Y, a value of 4 to 6, and a chroma of 2 to 4. Clay content ranges from about 29 to 34 percent. The B3 horizon generally has a hue of 10YR or 2.5Y, a value of 4 to 6, and a chroma of 1 to 6. Reaction is medium acid to strongly acid in the most acid part of the solum.

Atterberry soils formed in material similar to that in which Downs and Muscatine soils formed, and they are closely associated with Downs, Franklin, Tama, and Walford soils. They have a thinner, lighter colored A horizon than Muscatine soils. They are more poorly drained and have a grayer B horizon than Downs soils. They have a browner B horizon and are better drained than Walford soils. Atterberry soils have a solum that formed in more than 40 inches of loess, whereas Franklin soils have a solum that formed partly in loess and partly in loam glacial till.

Atterberry silt loam, 0 to 2 percent slopes (291A).—This soil is on upland divides and at the head of drainageways. It is associated with Downs, Franklin, Tama, and Walford soils on uplands. The profile of this soil is the one described as representative for the series. Plowing has mixed part of the platy subsurface layer into the surface layer. This plow layer puddles during intense rains, forming a crust that retards plant growth at times.

Included with this soil in mapping are small areas of well-drained soils. Small areas of poorly drained Walford soils are also included. These areas are indicated on the soil map by a special wet spot symbol. These small areas hinder farming operations unless they are drained.

This soil is well suited to intensive production of corn and soybeans if it is properly managed. In places it has a moderately high water table during wet years and benefits from tile drainage. Capability unit I-2; woodland suitability group 7.

Atterberry silt loam, 2 to 5 percent slopes (291B).—This soil is at the head of drainageways and at the base of slopes. It is associated with Downs, Muscatine, and Tama soils on uplands. The surface layer is very dark grayish brown. Plowing has mixed part of the platy subsurface layer into the surface layer. This plow layer puddles during intense rains, forming a crust that retards plant growth at times.

This soil is well suited to row crops. It receives runoff and seepage from soils upslope, and tile drainage is generally needed to remove seepage and to permit timely field operations. Capability unit IIe-3; woodland suitability group 7.

Atterberry silt loam, benches, 0 to 2 percent slopes (T291A).—This soil is on loess-covered benches of major streams. It is associated with Muscatine, Tama, and Walford soils on benches. Sand is below a depth of 48 inches in places. Plowing has mixed part of the platy subsurface layer into the surface layer. This plow layer puddles during intense rains, forming a crust that retards plant growth at times.

Included with this soil in mapping are small areas of soils that have 6 to 20 inches of overwash. These soils are lower in content of organic matter than this Atter-

berry soil. Also included are some areas of gently sloping soils. A few areas of poorly drained Walford soils are included. These areas are indicated on the soil map by a special symbol. Farming operations are delayed unless these soils are drained.

This soil is well suited to intensive row crops if it is properly managed. It has a moderately high water table during wet years, and it benefits from tile drainage in some years. Diversions are needed in places to protect some areas from runoff from higher lying soils. Capability unit I-2; woodland suitability group 7.

Atterberry silt loam, sandy substratum, 0 to 2 percent slopes (351A).—This soil is associated with other silty bench soils such as Tell, Waukegan, and Whittier. Sand is at a depth of about 40 to 50 inches. Plowing has mixed part of the platy subsurface layer into the surface layer. This plow layer puddles during intense rains, forming a crust that retards plant growth at times.

Included with this soil in mapping are a few areas of gently sloping soils. Also included are some wet areas that are indicated on the soil map by a special symbol. These areas hinder farming operations unless they are drained.

This soil is suited to intensive row crops if it is well managed. It has a moderately high water table during wet years, and it benefits from tile drainage. Placement of tile is difficult in some places because loose, water-bearing sand is at a depth of about 40 to 50 inches. Capability unit I-2; woodland suitability group 7.

Bassett Series

The Bassett series consists of moderately well drained soils on uplands. These soils formed in 14 to 26 inches of loamy material and underlying glacial till. These soils are gently sloping on ridgetops and moderately sloping to very steep on sides of ridges. Native vegetation was mixed prairie grasses and trees.

In a representative profile the plow layer is very dark grayish-brown loam about 8 inches thick. The subsoil is about 39 inches thick. The upper 11 inches is brown and yellowish-brown, friable loam. The lower 28 inches is yellowish-brown, firm loam that has gray mottles below a depth of 31 inches. The substratum is yellowish-brown, mottled, firm loam that is calcareous.

Bassett soils have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. In places, water accumulates at the till contact, causing wet, seepy spots in some years. Available water capacity is high. These soils are low in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

The gently sloping to moderately sloping areas of Bassett soils are well suited to row crops. In some areas stones or boulders interfere with cultivation.

Representative profile of Bassett loam, 2 to 5 percent slopes, in a north-facing area in a cultivated field, 340 feet east and 25 feet north of the southwest corner of SE¼SE¼ sec. 25, T. 86 N., R. 6 W.:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) loam; cloddy, breaking to weak, fine, granular structure; slightly acid; abrupt boundary.

B1—8 to 12 inches, brown (10YR 4/3) loam, some very dark grayish-brown (10YR 3/2) material from Ap horizon; weak, fine, subangular blocky structure; friable; medium acid; clear boundary.

B21—12 to 19 inches, yellowish-brown (10YR 5/4) loam; dark yellowish-brown (10YR 4/4) ped exteriors; weak, medium, subangular blocky structure; friable; very strongly acid; gradual boundary.

IIB22t—19 to 31 inches, yellowish-brown (10YR 5/4) heavy loam; weak, medium, subangular blocky structure; firm; thin discontinuous clay films; discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; very strongly acid; gradual boundary.

IIB23t—31 to 39 inches, yellowish-brown (10YR 5/4) heavy loam; brown (10YR 5/3) ped exteriors; few, fine, distinct, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) mottles; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; firm; few, thin, discontinuous clay films; light brownish-gray (10YR 6/2, dry) grainy coatings; few dark oxide concretions; strongly acid; gradual boundary.

IIB3—39 to 47 inches, yellowish-brown (10YR 5/4) loam; many, medium, distinct, gray to light-gray (10YR 6/1) mottles; weak, coarse, prismatic structure; firm; few dark oxide concretions; neutral; gradual boundary.

IIC—47 to 60 inches, yellowish-brown (10YR 5/4) heavy loam; many, medium, distinct, gray to light-gray (10YR 6/1) mottles; massive; firm; few dark oxide concretions; calcareous.

The solum ranges from 40 to 60 inches in thickness. Depth to glacial till ranges from about 14 to 26 inches in uneroded areas. In uncultivated areas the A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 6 to 9 inches in thickness. The A2 horizon is brown (10YR 4/3 to 10YR 5/3) and ranges from 4 to 6 inches in thickness. In places the A2 horizon is incorporated wholly into the Ap horizon. The upper part of the B horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 or higher, and it lacks distinct low-chroma mottles. Depth to low-chroma mottles ranges from 24 inches to about 34 inches. The IIB horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 3 or higher, and mottles have a lower chroma. The B horizon is typically heavy loam, but in places it is light clay loam or sandy clay loam. Reaction is strongly acid to very strongly acid in the most acid part of the solum.

Bassett soils formed in material similar to that in which Coggon and Kenyon soils formed, and they are associated with Floyd, Schley, and Waubeek soils. They have a thinner, lighter colored A horizon than Kenyon soils and a thicker dark A horizon than Coggon soils. Bassett soils have more sand in the upper part of the solum and are shallower to glacial till than Waubeek soils. They have a browner subsoil and are better drained than Floyd and Schley soils.

Bassett loam, 2 to 5 percent slopes (171B).—This soil is on convex ridges and side slopes. It is commonly adjacent to Coggon, Floyd, Oran, Schley, or Waubeek soils. The profile of this soil is the one described as representative for the series. In uncultivated areas the surface layer is very dark gray to very dark grayish-brown, friable loam, and the subsurface layer is platy and is distinctly lighter colored than the surface layer.

Included with this soil in mapping are small areas of sand and gravel that are indicated on the soil map by special symbols. These small areas are droughty, and they are less productive than this Bassett soil.

This soil is well suited to row crops commonly grown in the county. It is subject to slight erosion if it is cultivated. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tile drainage is needed in some areas. Fieldwork is delayed slightly at times because of wetness. Capability unit IIe-1; woodland suitability group 6.

Bassett loam, 5 to 9 percent slopes (171C).—This soil is on short, convex sides of ridges on uplands. Most areas are in the vicinity of larger streams. This soil is below gently sloping Bassett soils and upslope from Clyde, Floyd, or Schley soils. The plow layer is very dark grayish-brown loam about 6 inches thick.

Because permeability is moderate in the loamy overburden and moderately slow in the glacial till, water tends to accumulate at the till contact and then moves downhill along this contact. Because this soil typically is at a lower elevation than other Bassett soils, seepy spots are likely to occur in spring, especially in wet years.

This soil is suited to row crops. It is subject to moderate to severe erosion if it is cultivated. In places fieldwork is delayed slightly in wet seasons. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tile drainage is needed in some areas. Capability unit IIIe-1; woodland suitability group 6.

Bassett loam, 5 to 9 percent slopes, moderately eroded (171C2).—This soil is on short, convex side slopes on uplands. Most areas are in the vicinity of larger streams. This soil is below less sloping Bassett soils and above areas of Clyde, Floyd, or Schley soils. The plow layer is mixed very dark grayish brown and brown, and part of the subsoil is mixed into it. Also, glacial till is at a depth of 10 to 14 inches and is exposed in a few severely eroded spots. Because of erosion, this soil is lower in content of organic matter in the surface layer, lower in available potash, and shallower to the low-fertility firm till subsoil than uneroded Bassett soils.

Included with this soil in mapping are a few areas of sandy soils that have a lower available water capacity than the surrounding soil and that show the effects of drought more quickly.

Water tends to accumulate at the contact between the loamy overburden and the glacial till, and then it moves downhill and comes to the surface at lower elevations. Because this soil typically is at a lower elevation than other Bassett soils, wet seepy spots are likely to occur in spring, especially in wet years.

This soil is suited to row crops if it is well managed. It is subject to further erosion if it is cultivated. Fieldwork is slightly delayed in wet seasons. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tile drainage is needed in some areas. Capability unit IIIe-1; woodland suitability group 6.

Bassett loam, 9 to 14 percent slopes, moderately eroded (171D2).—This soil is on side slopes on uplands. It is below less sloping Bassett soils. The plow layer is very dark grayish-brown to brown, friable loam, and the subsurface layer is mixed into the plow layer.

Included with this soil in mapping are small areas of slightly eroded soils that are higher in content of organic matter and in fertility than this Bassett soil. Also included are areas of severely eroded soils that have little or no topsoil and are lower in content of organic matter and in available potash than this soil. These severely eroded areas are indicated on the soil map by a special symbol. A few areas of soils in which the firm heavy loam till is deeper than that in this soil are also included. Small areas of sand or gravel or limestone outcrops are included, and they are indicated on the map by special symbols. The areas of sand and gravel are droughty and are less productive than this soil, and the limestone outcrops interfere with farming operations.

This soil is suited to row crops if it is properly managed and erosion is controlled. Construction of terraces exposes the subsoil, which has low fertility, and additional fertilizer and organic matter are needed for crop production. Also, wet spots form in places for short periods following terrace construction because the lower part of the subsoil has moderately slow permeability. Capability unit IIIe-2; woodland suitability group 6.

Bassett loam, 14 to 18 percent slopes, moderately eroded (171E2).—This soil is on convex side slopes on uplands and is below less sloping Bassett soils. The profile of this soil is similar to the one described as representative for the series, but the surface layer is thinner. In cultivated areas the lighter colored subsurface layer is mixed into the plow layer.

Included with this soil in mapping are small areas of soils, in pasture and woodland, that are higher in content of organic matter and in fertility than this Bassett soil. Also included are areas of severely eroded soils that have little or no topsoil and are lower in content of organic matter and in fertility than this soil. These severely eroded areas are indicated on the soil map by a special symbol. Small areas of sand and gravel or limestone outcrops are included, and they are indicated on the soil map by special spot symbols. The areas of sand or gravel are droughty and are less productive than this soil, and the limestone outcrops interfere with farming operations.

This soil is better suited to hay, pasture, or woodland than to row crops. It can be used for row crops if the pastures are renovated. Capability unit IVe-1; woodland suitability group 6.

Bassett loam, 18 to 30 percent slopes, moderately eroded (171F2).—This soil is on uplands and in areas that are badly dissected by drainageways in side valleys. It has a profile similar to the one described as representative of the series, but the surface layer is thinner and lighter colored.

Included with this soil in mapping are areas of severely eroded soils that have little or no remaining topsoil and are lower in content of organic matter and in fertility than this Bassett soil. These severely eroded areas are indicated on the soil map by a special symbol.

This soil is better suited to pasture, timber, and wildlife habitat than to most other uses. In many areas it is difficult to renovate pastures safely with use of farm machinery because of the very steep slopes. Capability unit VIe-1; woodland suitability group 6.

Bertram Series

The Bertram series consists of somewhat excessively drained soils that formed in 20 to 40 inches of sandy loam and a thin layer of limestone residuum underlain by limestone bedrock. These soils are gently sloping to moderately sloping and are on side slopes and ridges on uplands and in benchlike areas. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown sandy loam

about 17 inches thick. The upper part of the subsoil is dark-brown and dark yellowish-brown, friable sandy loam that grades to firm sandy clay loam in the lower part. The substratum, at a depth of 34 inches, is dark yellowish-brown loamy sand and shattered limestone. Hard limestone bedrock is at a depth of 36 inches.

Bertram soils have low to very low available water capacity. They have moderately rapid permeability in the upper part of the profile and moderately slow permeability in the clayey residuum. They are very low in available nitrogen, phosphorus, and potassium. These soils are acid where they have not been limed within the last 2 or 3 years.

These soils are suited to row crops if they are properly managed. They are droughty and are subject to both soil blowing and water erosion.

Representative profile of Bertram sandy loam, 2 to 5 percent slopes, in a cultivated field, 520 feet east and 720 feet south of the northwest corner of SE¼SW¼ sec. 1, T. 86 N., R. 6 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) sandy loam; very weak cloddy, breaking to weak, fine, granular structure; very friable; neutral; abrupt boundary.

A3—8 to 17 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) sandy loam; very weak, fine, subangular blocky structure; very friable; slightly acid; gradual boundary.

B21—17 to 27 inches, dark-brown (10YR 3/3) and dark yellowish-brown (10YR 4/4) sandy loam, brown (10YR 4/3) when kneaded; very weak, coarse, subangular blocky structure; very friable; medium acid; clear boundary.

B22—27 to 30 inches, dark yellowish-brown (10YR 4/4) heavy sandy loam; weak, medium, subangular blocky structure; friable; medium acid; clear boundary.

IIB23t—30 to 34 inches, dark yellowish-brown (10YR 4/4) sandy clay loam; moderate, fine, subangular blocky structure; firm; thin discontinuous clay films; medium acid; abrupt boundary.

IIR1—34 to 36 inches, dark yellowish-brown (10YR 4/4) loamy sand, some hard limestone fragments ½ to 1 inch in diameter; fragments as much as 50 percent of volume; mildly alkaline.

IIR2—36 inches, hard limestone bedrock.

The solum typically is about 30 inches thick, but ranges from 20 to 40 inches in thickness. Thickness of the solum and depth to limestone bedrock commonly decrease as slope increases. The Ap or A1 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon ranges from 14 to 20 inches in thickness. The B2 horizon has a hue of 10YR, a value that is dominantly 3 to 5, and a chroma of 3 or 4. The B2 horizon typically is sandy loam but ranges to light sandy clay loam. The IIB horizon, or the residuum, ranges from 2 to 6 inches in thickness and from sandy clay loam to clay. Reaction is medium acid to strongly acid in the most acid part of the solum.

Bertram soils are associated with Dickinson, Kenyon, Olin, Rockton, and Sparta soils. They are underlain by limestone at a depth of less than 40 inches, but Dickinson, Kenyon, Olin, and Sparta soils are not. They contain more sand in the B horizon than Rockton soils.

Bertram sandy loam, 2 to 5 percent slopes (809B).—This soil is on convex ridges and short side slopes on uplands and in benchlike areas. It is commonly associated with Dickinson, Kenyon, Rockton, and Sparta soils. It has the profile described as representative for the series.

Included with this soil in mapping are small areas of soils that are nearly level. Areas of soils that have a thinner surface layer and a lighter colored surface and subsurface layer than this Bertram soil are included. Also included are a few spots where limestone outcrops are on the surface.

This soil is not well suited to row crops because of droughtiness. It is subject to soil blowing if the surface layer is left unprotected. Capability unit IVs-1; woodland suitability group 3.

Bertram sandy loam, 5 to 9 percent slopes (809C).—This soil is on short side slopes and narrow ridges on uplands and in benchlike areas. It is downslope from less sloping Bertram soils and is commonly associated with Dickinson, Olin, Rockton, and Sparta soils. It has a profile similar to the one described as representative for the series, but the surface layer is not so dark or so thick. The plow layer is a very dark grayish-brown, very friable sandy loam.

Included with this soil in mapping are areas of moderately eroded soils that are lower in content of organic matter and in available nitrogen than this Bertram soil. Also included are a few spots where limestone outcrops are on the surface.

This soil is not well suited to row crops because of droughtiness. It is subject to soil blowing and water erosion if it is cultivated. Capability unit IVs-1; woodland suitability group 3.

Bertrand Series

The Bertrand series consists of well-drained soils that formed in silty alluvium. These soils are nearly level and gently sloping on stream benches near major streams. Native vegetation was trees.

In a representative profile the surface layer is dark grayish-brown silt loam about 7 inches thick. The subsoil is about 38 inches thick. It is brown, dark yellowish-brown, and yellowish-brown, friable silt loam. The substratum, at a depth of 45 inches, is yellowish-brown, stratified coarse sandy loam and silt loam.

Bertrand soils have moderate permeability and high available water capacity. These soils are very low in available nitrogen and potassium and medium in available phosphorus. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops, but good management is needed to maintain good production.

Representative profile of Bertrand silt loam, 0 to 2 percent slopes, in an idle field, 442 feet north and 78 feet east of the southwest corner of NW¼SW¼ sec. 29, T. 83 N., R. 6 W.:

Ap—0 to 7 inches, dark grayish-brown (10YR 4/2) and light brownish-gray (10YR 6/2, dry) silt loam; some brown (10YR 4/3) material from B1 horizon; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

B1—7 to 11 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; friable; few, discontinuous, light-gray (10YR 7/1, dry), grainy coatings; slightly acid; gradual boundary.

B2t—11 to 19 inches, dark yellowish-brown (10YR 4/4) heavy silt loam; brown (10YR 4/3) ped exteriors; weak, medium, subangular blocky structure; friable; few, thin, discontinuous, dark-brown (10YR 3/3) clay films; thin, discontinuous, light-gray (10YR 7/1, dry), grainy coatings; slightly acid; gradual boundary.

B22t—19 to 33 inches, yellowish-brown (10YR 5/6) heavy silt loam; dark yellowish-brown (10YR 4/4) ped

exteriors; moderate, medium, subangular blocky structure; friable; discontinuous dark-brown (10YR 3/3) clay films; nearly continuous, light-gray (10YR 7/1, dry), grainy coatings; slightly acid; gradual boundary.

B3t—33 to 45 inches, yellowish-brown (10YR 5/6) medium silt loam; dark yellowish-brown (10YR 4/4) ped exteriors; weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky structure; friable; sand increases as depth increases; few, patchy, dark-brown (10YR 3/3) clay films on prisms and in root channels; few black oxide concretions; strongly acid; gradual boundary.

C—45 to 60 inches, yellowish-brown (10YR 5/4) stratified coarse sandy loam and silt loam; few, medium, distinct, grayish-brown (10YR 5/2) mottles; massive; very friable; common black and dark-brown oxide concretions; some gravel 2 millimeters in diameter in lower part of horizon; strongly acid.

The solum ranges from 40 to 60 inches or more in thickness, and depth to stratified loamy material ranges from about 42 to 50 inches. The Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). Where present, the A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It ranges from 3 to 6 inches in thickness. Where present, the A2 horizon is brown (10YR 4/3 or 5/3). It generally is 3 to 5 inches thick, and in places it is wholly incorporated into the plow layer. The B horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 8; it is free of low-chroma mottles. The B2 horizon ranges from heavy silt loam to light silty clay loam that has a clay content of about 22 to 28 percent. The C horizon is similar in color to the B2 and B3 horizons and ranges from silt loam to stratified layers of silt loam and sandy loam. It has coarse-textured loamy sand or sand at a depth below 48 inches in some places. Reaction ranges from medium acid to strongly acid in the most acid part of the solum.

Bertrand soils formed in material similar to that in which Richwood, Tell, Waukegan, and Whittier soils formed. They are associated with Atterberry soils on stream benches. They have a thinner, lighter colored A horizon than Richwood and Waukegan soils. Bertrand soils contain less sand in the lower part of the B horizon and are deeper over contrasting textures than Tell and Whittier soils. They have a browner B horizon and are better drained than Atterberry soils.

Bertrand silt loam, 0 to 2 percent slopes (793A).—This soil is on benches near major streams. It commonly is below Fayette soils and adjacent to gently sloping Bertrand soils. It is also associated with Atterberry soils on stream benches and with Tell soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of soils that contain more clay in the subsoil than this Bertrand soil and a few areas that have coarse-textured material at a depth of less than 40 inches.

This soil is well suited to intensive use for row crops. Because the content of organic matter is very low, the surface layer tends to seal and crust. Capability unit I-1; woodland suitability group 4.

Bertrand silt loam, 2 to 5 percent slopes (793B).—This soil is on benches near major streams. It commonly is below Fayette soils and is adjacent to Atterberry soils on stream benches and to Tell soils. The plow layer is dark grayish-brown silt loam that is lighter colored when dry. It is low in content of organic matter.

Included with this soil in mapping are small areas of soils that contain more clay in the subsoil than this soil or that have coarser textured material at a depth of less than 40 inches.

This soil is well suited to row crops if it is well managed, but it is subject to erosion if it is cultivated. In some places terraces are difficult to construct because slopes are short and irregular. Capability unit IIe-1; woodland suitability group 4.

Burkhardt Series

The Burkhardt series consists of excessively drained soils that formed in 10 to 20 inches of sandy loam and underlying gravelly loamy sand and sand. These soils are gently sloping to moderately steep and are on stream benches, convex high knolls, and side slopes on uplands. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown to very dark grayish-brown sandy loam about 10 inches thick. The subsoil is about 20 inches thick. It is dark-brown light sandy loam in the upper 5 inches and brown gravelly loamy sand and strong-brown gravelly sand in the lower 15 inches. The substratum is brown and strong-brown gravelly sand.

Burkhardt soils have very low available water capacity and very rapid permeability. These soils are very low in available nitrogen, phosphorus, and potassium. They are acid where they have not been limed within the last 3 years.

These soils can be used for row crops if they are properly managed, but they are droughty, even in years of average rain.

Representative profile of Burkhardt sandy loam, 2 to 9 percent slopes, in a cultivated field, 1,030 feet west and 40 feet south of the northeast corner of NE¼SE¼ sec. 30, T. 86 N., R. 7 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) heavy sandy loam; weak cloddy, breaking to weak, fine, granular structure; friable; strongly acid; abrupt boundary.

A3—7 to 10 inches, very dark grayish-brown (10YR 3/2) sandy loam; very dark brown (10YR 2/2) ped exteriors; weak, fine to medium, subangular blocky structure; friable; strongly acid; gradual boundary.

B1—10 to 15 inches, dark-brown (10YR 3/3) light sandy loam; weak, medium, subangular blocky structure; friable; strongly acid; gradual boundary.

IIB2t—15 to 27 inches, brown (7.5YR 4/4) gravelly loamy sand; weak, coarse, subangular blocky structure; clay bridging between sand grains; very friable; medium acid; gradual boundary.

IIB3t—27 to 30 inches, strong-brown (7.5YR 5/6) gravelly sand; very weak, coarse, subangular blocky structure; very friable; clay bridging between sand grains; medium acid; clear boundary.

IIC—30 to 60 inches, brown (7.5YR 4/4) and strong-brown (7.5YR 5/6) gravelly sand; single grain; loose; medium acid.

The solum ranges from about 20 to 30 inches in thickness, and depth to contrasting texture ranges from 10 to 20 inches. The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) and from 7 to 15 inches in thickness. The A horizon typically is sandy loam, but it ranges to light loam and gravelly sandy loam. The B2 horizon ranges from light sandy loam to gravelly loamy sand or sand. Reaction ranges from medium acid to very strongly acid in the most acid part of the solum.

Burkhardt soils are associated with Dickinson, Flagler, Sattre, Saude, Sparta, Wapsie, and Waukee soils. They are shallower to coarse sand and gravel than all these soils, and they have a coarser textured A horizon than Sattre, Saude, Wapsie, and Waukee soils. They contain more coarse sand and gravel throughout the solum than Dickinson and Sparta soils.

Burkhardt sandy loam, 2 to 9 percent slopes (285C).—This soil is on stream benches and ridges and side slopes on uplands. It is commonly associated with Dickinson, Flagler, Saude, Sattre, Wapsie, and Waukee soils or more sloping Burkhardt soils. It is also associated with Bassett and Kenyon soils on uplands. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are some areas of eroded soils where the surface layer is thinner and lighter colored than that of this soil and the content of organic matter is lower. Also included are small areas where gravel outcrops are on the surface. These areas are indicated on the soil map by spot symbols. They are more droughty and less productive than this soil.

This soil is not well suited to row crops. It is excessively drained and droughty and is subject to soil blowing and water erosion if it is cultivated. Crop production depends on the amount and timeliness of rain. Capability unit IVs-1; woodland suitability group 1.

Burkhardt sandy loam, 9 to 14 percent slopes, moderately eroded (285D2).—This soil is on side slopes and escarpments of stream benches. It is also on side slopes and ridges on uplands. It is commonly associated with Dickinson, Flagler, Saude, and Sparta soils or less sloping Burkhardt soils. It is also associated with Bassett and Kenyon soils on uplands. This soil has a profile similar to the one described as representative for the series, but the dark surface layer is thinner and gravel is at a shallower depth.

Included with this soil in mapping are areas of severely eroded soils where the surface layer is thinner and lighter colored than that of this soil, and fertility and the content of organic matter are lower. Also included are small areas where gravel outcrops are on the surface. These areas are indicated on the soil map by a special symbol. These areas are more droughty and less productive than this soil.

This soil is better suited to hay and pasture than to row crops. It is excessively drained and droughty. It is subject to soil blowing and water erosion if it is cultivated. Capability unit VIs-1; woodland suitability group 1.

Chelsea Series

The Chelsea series consists of excessively drained soils that formed dominantly in sand deposited by wind. These soils are generally nearly level to very steep on ridges and side slopes on uplands, but in a few areas they are nearly level to moderately sloping on stream benches. In the areas on stream benches, the sand is coarser textured than that in other areas and in places it contains some gravel at a depth below 4 feet. Native vegetation was trees.

In a representative profile the surface layer is very dark gray to very dark grayish-brown loamy fine sand and fine sand about 7 inches thick. It is underlain by brown, yellowish-brown, and light yellowish-brown fine sand. Very thin bands of brown light sandy loam are below a depth of 40 inches.

Chelsea soils have rapid permeability and very low available water capacity. These soils are very low in available nitrogen, phosphorus, and potassium. They are acid where they have not been limed within the last 3 or 4 years.

These soils are better suited to permanent pasture, woodland, and wildlife habitat than to most other uses.

Representative profile of Chelsea loamy fine sand, 5 to 9 percent slopes, in a south-facing, convex area in a woodlot, 200 feet north and 60 feet east of the northeast corner of SW¼SE¼ sec. 27, T. 86 N., R. 6 W.:

A11—0 to 1 inch, very dark gray (10YR 3/1) loamy fine sand, grayish brown (10YR 5/2) dry; weak, fine, granular structure; very friable; much decomposed leaf litter and many fine roots; slightly acid; abrupt boundary.

A12—1 to 4 inches, very dark grayish-brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; single grain; loose; medium acid to strongly acid; clear boundary.

AC—4 to 7 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) fine sand; light brownish gray (10YR 6/2) dry; single grain; loose; strongly acid; gradual boundary.

C1—7 to 15 inches, brown (10YR 4/3) fine sand, pale brown (10YR 6/3) dry; single grain moist and very weak, subangular blocky structure dry; loose; strongly acid; gradual boundary.

C2—15 to 36 inches, yellowish-brown (10YR 5/4) fine sand; single grain; loose; some sand grains are dark brown; strongly acid; gradual boundary.

C&B—36 to 70 inches, light yellowish-brown (10YR 6/4) fine sand; single grain; loose; ½- to 2-inch brown (7.5YR 4/4) light sandy loam bands at depths of 43, 49, 53, 59, and 67 inches; strongly acid.

The solum ranges from 4 feet to many feet in thickness. In uncultivated areas the solum ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) and is 3 to 5 feet thick. The Ap horizon is dark grayish brown (10YR 4/2), dark brown (10YR 3/3), or brown (10YR 4/3). The A horizon ranges from loamy fine sand to fine sand. The C&B horizon consists of lamellae ¼ inch to 2 inches in thickness. It has a hue of 7.5YR or 10YR and a value and chroma of 3 or 4. Depth to the uppermost lamella ranges from 3 to 4 feet. Reaction is strongly acid to medium acid in the most acid part of the solum.

Chelsea soils formed in material similar to that in which Dickinson, Lamont, and Sparta soils formed. Chelsea soils have a higher sand content in the upper 3 feet than Lamont soils, and they have a thinner, lighter colored A horizon than Sparta soils. Chelsea soils have more sand in the upper part of the solum and a lighter colored A horizon than Dickinson soils.

Chelsea loamy fine sand, 0 to 2 percent slopes (63A).—This soil is on uplands and stream benches. In many places it is adjacent to more sloping Chelsea soils and to Lamont soils. The largest areas are on stream benches. In these areas the sand is coarser textured than that in other areas, and some gravel is below a depth of about 3 feet. Where cultivated, this soil typically has a dark grayish-brown plow layer. In uncultivated areas the surface layer is very dark gray or very dark grayish-brown.

Included with this soil in mapping are some areas of sand blowouts. These areas are indicated on the soil map by a special symbol. The areas of sand blowouts are very erodible and need additional plant cover to prevent further erosion.

This soil is not well suited to row crops. It is excessively drained and very droughty. In years when rainfall is very timely and above normal, crop production is greatly improved. Capability unit IVs-1; woodland suitability group 2.

Chelsea loamy fine sand, 2 to 5 percent slopes (63B).—This soil typically is on ridges and side slopes on uplands, but a few areas are on stream benches. It is commonly adjacent to more sloping Chelsea soils and to Lamont soils. In cultivated areas the plow layer is typically dark grayish brown when moist and lighter colored when dry.

Included with this soil in mapping are small areas where the surface layer is sandy loam. Also included in some sand blowouts, and these areas are indicated on the soil map by a special symbol. The areas of sand blowouts are very erodible and need additional plant cover to prevent further erosion.

This soil is not well suited to row crops. It is excessively drained and very droughty. Crop production depends on the amount and timeliness of rain. Capability unit IVs-1; woodland suitability group 2.

Chelsea loamy fine sand, 5 to 9 percent slopes (63C).—This soil typically is on moundlike ridges and side slopes on uplands, but a few areas are on stream benches. It is commonly adjacent to more sloping Chelsea soils and to Lamont soils. The profile of this soil is the one described as representative for the series. In cultivated areas the plow layer is dark grayish brown or brown.

Included with this soil in mapping are small areas of soils where the surface layer is sandy loam. Also included in places are areas of sand blowouts, and these areas are indicated on the soil map by a special symbol.

This soil is not well suited to row crops. It is low in fertility and very droughty. Capability unit IVs-1; woodland suitability group 2.

Chelsea loamy fine sand, 9 to 18 percent slopes (63D).—This soil is on side slopes on uplands and is adjacent to more sloping Chelsea soils. In uncultivated areas it has a thin, very dark gray to very dark grayish-brown surface layer. In some wooded areas this soil has as much as 1½ inches of leaf litter on the surface. In cultivated areas the plow layer is dark grayish brown or brown.

Included with this soil in mapping are some areas of sand blowouts and outcrops of limestone, which are indicated on the soil map by special symbols. The areas of sand blowouts are very erodible and require additional plant cover to prevent further erosion. The limestone interferes with farming.

Permanent pasture, hay, timber, and wildlife habitat are better uses for this soil than row crops. This soil is excessively drained and droughty. If the surface layer is left unprotected, it is subject to soil blowing and water erosion. Capability unit VIs-1; woodland suitability group 2.

Chelsea loamy fine sand, 18 to 30 percent slopes (63F).—This soil is in irregularly shaped, convex areas on uplands. It is commonly associated with less sloping Chelsea soils and, in places, with Fayette and Lamont soils. The color of the surface layer ranges from very dark gray in areas that are uncultivated to brown in areas that are eroded. In some wooded areas, this soil has 1½ inches of leaf litter on the surface.

Included with this soil in mapping are areas of cultivated soils in which nearly all of the surface layer has been removed by soil blowing or water erosion. These soils are lower in fertility and content of organic matter than this soil. Also included are areas of sand blowouts which are indicated on the soil map by a special symbol. The areas of sand blowouts are very erodible and require additional plant cover to prevent further erosion.

This soil is better suited to woodland and wildlife habitat than to most other uses. Because slopes are steep, many areas that are pastured are difficult to renovate with use of regular farm machinery. Capability unit VIIs-1; woodland suitability group 2.

Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes (293C).—This complex consists of about 40 percent Chelsea soils, about 30 percent Lamont soils, and about 30 percent Fayette soils. It is on ridgetops and side slopes on uplands, mainly bordering Cedar and Wapsipinicon Rivers and Buffalo Creek. These soils have the profiles described as representative for their respective series.

Most areas of these soils are in pasture or timber. If these soils are well managed, they are moderately well suited to row crops. Production depends on the amount and timeliness of rain. All these soils are subject to erosion, and the Chelsea and Lamont soils are quite droughty. Terraces are suitable in a few areas where the Fayette soils predominate, but topography is generally not uniform, and construction of terraces is difficult. Capability unit IIIe-3; woodland suitability group 2.

Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes, moderately eroded (293C2).—This complex consists of about 40 percent Chelsea soils, about 30 percent Lamont soils, and about 30 percent Fayette soils. It is on ridgetops and side slopes on uplands bordering the Cedar and Wapsipinicon Rivers and Buffalo Creek.

The Fayette soil has a profile similar to the one described as representative for the Fayette series, but the surface layer is browner and the content of organic matter is lower. The Chelsea and Lamont soils have a profile similar to the one described as representative for their respective series.

Included with these soils in mapping are some areas of severely eroded soils that are indicated on the soil map by a spot symbol. In these areas the yellowish-brown subsoil is exposed at the surface, and fertility and the content of organic matter is lower than in the soils of this complex. Also included in places are areas of sand blowouts, and these areas are indicated on the soil map by a spot symbol. These areas are droughty and less productive than the surrounding soils.

These soils are moderately well suited to row crops if they are well managed. Irregular topography and sandy areas make construction of terraces difficult. This complex is subject to further erosion, and the Chelsea and Lamont soils are droughty. Capability unit IIIe-3; woodland suitability group 2.

Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes (293D).—This complex consists of about equal amounts of Chelsea, Lamont, and Fayette soils. It is on uplands and borders Cedar and Wapsipinicon Rivers and Buffalo Creek.

Most areas of these soils are in timber or pasture, and the soils are better suited to this use than to row crops. Row crops generally are grown only to reestablish grass-legume hay and pasture. Pasture-carrying capacity depends on the amount and timeliness of rain. These soils are subject to erosion, and Chelsea and Lamont

soils are droughty. Capability unit VIe-1; woodland suitability group 2.

Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes, moderately eroded (293D2).—This complex consists of about equal amounts of Chelsea, Lamont, and Fayette soils. These soils are on uplands bordering Cedar and Wapsipinicon Rivers and Buffalo Creek. In areas of these soils that are cultivated, erosion has removed part of the surface and subsurface layers. The plow layer is lighter colored and lower in content of organic matter and in fertility than soils in the uneroded complex.

Included with these soils in mapping are some areas of severely eroded soils where yellowish-brown subsoil is exposed at the surface. These soils are lower in content of organic matter and in fertility than the soils in this complex. These areas are indicated on the soil map by a special symbol.

This complex is better suited to permanent pasture and timber than to row crops. Row crops generally are grown only when pastures need to be renovated. Pasture-carrying capacity depends on the amount and timeliness of rain. Capability unit VIe-1; woodland suitability group 2.

Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes (293F).—This complex consists of about equal amounts of Chelsea, Lamont, and Fayette soils. It is on uplands bordering Cedar and Wapsipinicon Rivers and Buffalo Creek.

Most areas of these soils are in timber or pasture. These soils are better suited to pasture, hay, and wildlife habitat than to most other uses. Renovation of pastures is difficult because of steep slopes. Pasture-carrying capacity depends on the amount and timeliness of rain. Capability unit VIIe-1; woodland suitability group 2.

Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes, moderately eroded (293F2).—This complex consists of about equal amounts of Chelsea, Lamont, and Fayette soils. These soils are on uplands bordering Cedar and Wapsipinicon Rivers and Buffalo Creek. They have been or are under cultivation, and erosion has removed part of the surface and subsurface layers. They are lower in content of organic matter and in available nitrogen than soils in the uneroded complex.

Included with these soils in mapping are small areas of severely eroded soils where yellowish-brown subsoil is exposed at the surface. These soils are lower in content of organic matter than the soils in this complex. These small areas are indicated on the soil map by a special symbol for severe erosion.

These soils are not suited to row crops. They are better suited to pasture, timber, and wildlife habitat. They are subject to further erosion, and Chelsea and Lamont soils are droughty. In many areas safe renovation of pastures with use of farm machinery is difficult because of steep slopes. Pasture-carrying capacity depends on the amount and timeliness of rain. Capability unit VIIe-1; woodland suitability group 2.

Clyde Series

The Clyde series consists of poorly drained, nearly level to gently sloping soils in drainageways and in low, concave areas on uplands. These soils formed in 24 to 50 inches of moderately fine textured and medium-textured material and underlying friable or firm glacial till or stratified valley fill. A band of pebbles commonly separates the glacial till and the overlying material. Rocks and boulders are on the surface or throughout the subsoil in some places. Native vegetation was grasses and sedges.

In a representative profile the surface layer is black and very dark gray silty clay loam about 21 inches thick. The upper part of the subsoil, to a depth of 41 inches, is olive-gray, mottled, friable heavy loam that has strata of loamy sand that contains a few pebbles. The lower part of the subsoil and the substratum, to a depth of 60 inches is mottled olive-gray and yellowish-brown, mottled firm loam.

Clyde soils have high available water capacity. They are moderately permeable but are wet because of hillside seepage from Floyd and Kenyon soils, which are commonly upslope. This wetness causes a variable but high water table in the Clyde soils. These soils are low to medium in available nitrogen, very low in available phosphorus, and very low in available potassium. In most places they are neutral in reaction and lime is not needed.

Where these soils are drained, they are commonly used for intensive row cropping. Other areas are in permanent pasture or are idle.

Representative profile of Clyde silty clay loam, in a permanent pasture, 335 feet north and 115 feet west of the southeast corner of NW¼SE¼ sec. 26, T. 86 N., R. 6 W.:

A1—0 to 16 inches, black (10YR 2/1) silty clay loam; weak, fine, granular structure; friable; neutral; gradual boundary.

A3—16 to 21 inches, very dark gray (10YR 3/1) silty clay loam; common, fine, distinct, olive-brown (2.5Y 4/4) mottles; weak, fine, subangular blocky structure; friable; neutral; gradual boundary.

B21g—21 to 28 inches, olive-gray (5Y 5/2) heavy loam; gray (5Y 5/1) ped exteriors; common, fine, distinct, light olive-brown (2.5Y 4/4) mottles; weak, fine, subangular blocky structure; friable; few black oxide concretions; neutral; gradual boundary.

B22g—28 to 41 inches, olive-gray (5Y 5/2) heavy loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few black oxide concretions; 1-inch strata of mottled yellowish-brown (10YR 5/6) and olive-brown (2.5Y 4/4) loamy sand containing a few pebbles 2 millimeters in diameter; neutral; gradual boundary.

IIB31—41 to 52 inches, mottled olive-gray (5Y 5/2) and yellowish-brown (10YR 5/6) heavy loam; weak, coarse, prismatic structure; firm; 1-inch strata of loamy sand containing some pebbles 2 millimeters in diameter at a depth of 46 to 47 inches; neutral; gradual boundary.

IIC—52 to 60 inches, mottled olive-gray (5Y 5/2) and yellowish-brown (10YR 5/6) heavy loam; massive; firm; neutral.

The solum typically is more than 42 inches thick but ranges from 18 to 60 inches or more in thickness. Depth to erosion sediment over glacial till is typically 36 to 42 inches but ranges from 18 to 60 inches. The A horizon ranges from about 20 to 24 inches in thickness. It ranges from silty clay loam or clay loam to silt loam or loam. The B horizon commonly is clay loam or loam, but in places the B horizon consists of layers of silty clay loam and sandy loam, typically less than 6 inches thick. Reaction is typically neutral through-

out the solum but ranges to slightly acid in the most acid part.

Clyde soils are associated with Floyd soils and are in the same drainage class as Marshan, Maxfield, and Tripoli soils. They are more poorly drained and have a grayer B horizon than Floyd soils, and they are more stratified and deeper over till than both Floyd and Tripoli soils. They are not underlain by sand and gravel as are Marshan soils. They contain more sand in the upper part of the B horizon than Maxfield soils.

Clyde silty clay loam (0 to 3 percent slopes) (84).—This soil is in drainageways and in lower concave areas on uplands. In most places it is adjacent to Floyd soils and is downslope from Kenyon soils.

Included with this soil in mapping are a few small areas of soils that have slopes of more than 3 percent. Also included are some small, sandy areas and marshy spots that are indicated on the map by spot symbols. The marshy areas hinder farming operations, especially after periods of intense rain.

This soil is well suited to intensive row crops if it is properly drained. It is wet because of seepage and runoff from soils upslope. Tilth is generally good, but this soil puddles if it is worked when wet. Because wetness is caused in part by sidehill seepage, a drainage system that intercepts laterally moving water is more effective than other types. Stones and boulders are common in many areas and need to be removed before this soil can be cropped. Stones and boulders also interfere with tile installation at times. Capability unit IIw-1; woodland suitability group 9.

Clyde-Floyd-Schley complex, 1 to 4 percent slopes (391B).—This complex consists of about 40 percent Clyde soils, 30 percent Floyd soils, and 30 percent Schley soils. The percentage of Schley soils is greater in areas where soils adjacent to the complex have a higher content of sand. The soils in this complex are poorly drained and somewhat poorly drained. These soils are in small upland drainageways and are associated with better drained and more sloping Bassett and Kenyon soils. In most places the Clyde soil is in the lower part of the drainageway and a band of the Floyd soil borders it. The Schley soil is commonly at the head of drainageways and typically is more acid than Clyde or Floyd soils.

These soils are suited to row crops if they are properly drained, but many areas are left in waterways to prevent formation of gullies. Large boulders are common, and they must be removed before the soils can be cropped. Most of this complex is farmed with surrounding soils, because individual areas are generally too small to be cropped separately. These soils receive seepage and runoff from more sloping soils. Tile drainage works well if outlets are suitable. Drainageways that have a high concentration of water should be in grass. Capability unit IIw-1; woodland suitability group 9.

Coggon Series

The Coggon series consists of moderately well drained soils that formed in 14 to 24 inches of loamy material and underlying glacial till. These soils are moderately sloping and are on upland ridges and side slopes. The native vegetation was trees.

In a representative profile the surface layer is very dark gray loam about 4 inches thick. The subsurface layer is dark grayish-brown loam about 5 inches thick. The subsoil is about 51 inches thick. The upper 23 inches is brown and yellowish-brown loam. The next 9 inches is yellowish-brown, firm loam that contains mottles. The lower 19 inches is mottled yellowish-brown, light-gray, and light-brownish gray, firm loam.

Coggon soils are moderately permeable in the friable upper part of the subsoil and moderately slowly permeable in the firm lower part. Water moves more rapidly in the loamy overburden than in the glacial till, and it accumulates at the glacial till contact, resulting in wet seepy spots in some years. These soils have high available water capacity. They are very low to low in available nitrogen, low in available phosphorus, and very low in available potassium. They contain little organic matter, except in the surface layer of undisturbed areas. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops if they are properly managed.

Representative profile of Coggon loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field, 400 feet west and 100 feet south of the northeast corner of NE¼ NW¼ sec. 12, T. 84 N., R. 8 W.:

A1—0 to 4 inches, very dark gray (10YR 3/1) light loam; weak, fine, granular structure; friable; slightly acid; clear boundary.

A2—4 to 9 inches, dark grayish-brown (10YR 4/2) light loam; weak, thin, platy structure; friable; medium acid; clear boundary.

B1—9 to 14 inches, brown (10YR 5/3) loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21t—14 to 24 inches, yellowish-brown (10YR 5/6) heavy loam; brown (10YR 5/3) ped exteriors; moderate, fine, subangular blocky structure; friable; few, thin, discontinuous clay films; discontinuous, light-gray (10YR 7/2, dry), grainy coatings; strongly acid; clear boundary.

IIB22t—24 to 32 inches, yellowish-brown (10YR 5/6) heavy loam that contains numerous pebbles; moderate, medium, subangular blocky structure; firm; thin discontinuous clay films; nearly continuous, light-gray (10YR 7/2, dry), grainy coatings; numerous black oxide concretions; discontinuous band of pebbles at a depth of 25 to 26 inches; strongly acid; gradual boundary.

IIB23t—32 to 41 inches, yellowish-brown (10YR 5/6) heavy loam that contains some pebbles; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles and common, distinct, light-gray (10YR 7/2) mottles; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky structure; firm; discontinuous clay films on surface of peds and in root channels; numerous black oxide concretions; strongly acid; gradual boundary.

IIB31t—41 to 60 inches, mottled yellowish-brown (10YR 5/6), light gray (10YR 7/2), and light brownish-gray (2.5Y 6/2) heavy loam that contains some pebbles; weak, coarse, prismatic structure; firm; few, thin, discontinuous clay films on surfaces of peds and in root channels; numerous black oxide concretions; strongly acid.

The solum typically is about 60 inches thick but ranges from 50 to 70 inches in thickness. The A1 horizon is 2 to 4 inches thick and is commonly very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). Where present, the Ap horizon typically is dark grayish brown (10YR 4/2) or brown (10YR 4/3). The A2 horizon is dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), or brown (10YR 4/3

or 5/3). In somewhat eroded areas most of the A2 horizon is incorporated into the Ap horizon. The A horizon is typically loamy but ranges to silt loam that contains enough sand to have a gritty feel. The upper part of the B horizon ranges from brown (10YR 4/3) to yellowish brown (10YR 5/6). The lower part of the B horizon is yellowish brown (10YR 5/4, 5/6) or strong brown (7.5YR 5/6, 5/8), and mottles that have a chroma of 2 or lower increase in size and number as depth increases below a depth of about 30 inches. The B2 horizon commonly is heavy loam but ranges to medium loam, light clay loam, or sandy clay loam.

Coggon soils formed in material similar to that in which Bassett, Kenyon, Oran, and Waubeek soils formed. They have a thinner or lighter colored A horizon than Bassett and Kenyon soils. They have a browner B horizon and are better drained than Oran soils. Coggon soils contain more sand in the upper part of the solum and are shallower to glacial till than Waubeek soils.

Coggon loam, 5 to 9 percent slopes, moderately eroded (302C2).—This soil is on convex ridges and side slopes. It commonly is adjacent to Bassett and Chelsea soils.

Included with this soil in mapping are areas that have been little affected by erosion. These areas are in pasture or woodland.

This soil is suited to row crops when it is properly managed. It is subject to further erosion if it is cultivated. Because permeability in the loamy overburden differs from that in the underlying glacial till, water tends to accumulate at a depth of 18 inches and produces a temporary high water table, especially early in spring. Because adequate erosion control and drainage are difficult, a combination of terracing and tile drainage is needed in some places. Capability unit IIIe-1; woodland suitability group 6.

Colo Series

The Colo series consists of poorly drained soils that formed in moderately fine textured alluvial deposits. These soils are nearly level and are on flood plains and in upland drainageways. Native vegetation was water-tolerant grasses and sedges.

In a representative profile the surface layer is black silty clay loam about 38 inches thick. The next layer is very dark gray silty clay loam about 7 inches thick. The substratum, at a depth of 45 inches, is olive-gray silty clay loam that has light olive-brown to strong-brown mottles.

Colo soils have moderately slow permeability and high available water capacity. They are low to medium in available nitrogen, medium in available phosphorus, and very low in available potassium. They generally are neutral to slightly acid and generally do not need lime.

Areas of these soils that are not subject to overflow too frequently or are not cut up by old stream channels are suited to intensive row cropping. Areas that are frequently subject to overflow generally are in pasture.

Representative profile of Colo silty clay loam, in a permanent pasture, 620 feet east and 100 feet south of the northwest corner of SE¼SE¼ sec. 14, T. 82 N., R. 7 W.:

A1—0 to 13 inches, black (N 2/0) silty clay loam; moderate, fine, granular structure; friable; slightly acid; gradual boundary.

A12—13 to 20 inches, black (N 2/0) silty clay loam; moderate, very fine, subangular blocky structure; friable; neutral; gradual boundary.

A13—20 to 38 inches, black (N 2/0) silty clay loam; moderate, fine, prismatic structure breaking to moderate, medium, angular and subangular blocky structure; firm; neutral; gradual boundary.

AC—38 to 45 inches, very dark gray (10YR 3/1) silty clay loam; moderate, fine, prismatic structure; firm; neutral; gradual boundary.

C1g—45 to 53 inches, olive-gray (5Y 5/2) light silty clay loam; few, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak, coarse, prismatic structure; firm; dark-gray (10YR 4/1) coatings around old root channels; black (N 2/0) krotovinas about 2 inches in diameter; neutral; gradual boundary.

C2g—53 to 61 inches, olive-gray (5Y 5/2) light silty clay loam; many, fine, prominent, strong-brown (7.5YR 5/6) mottles; massive; friable; neutral.

The A horizon ranges from 36 inches to about 50 inches in thickness. The A horizon is black or very dark gray silty clay loam. In the A horizon, value is 2 or 3 and chroma is 0 or 1. The upper 10 inches of the A horizon ranges to heavy silt loam. Below a depth of 10 inches the clay content is commonly 30 to 35 percent, but thin layers that are as much as 38 percent clay. Colors that have a value of 2 or 3 extend to a depth of 36 inches or more. The C horizon has a hue of 2.5Y or 5Y, a value of 3 to 5, and a chroma of 1 or 2, but few to common high-chroma mottles occur in some places. In places sandy or gravelly horizons are below a depth of 48 inches. Reaction is slightly acid to neutral throughout the solum.

Colo soils are associated with Kennebec and Spillville soils and are in the same drainage class as Clyde and Marshan soils. Colo soils contain more clay and have a grayer C horizon than Kennebec and Spillville soils, which formed in similar material. They contain less sand and have a thicker A horizon than Clyde and Marshan soils.

Colo silt loam, overwash (0 to 2 percent slopes) (133+).—This soil is on flood plains and in narrow upland drainageways. It is commonly associated with Kennebec and Spillville soils on bottom lands.

The profile of this soil is similar to the one described as representative for the series, but it has 6 to 20 inches of recent overwash over a black silt loam surface layer. The overwash is dark-gray to dark-brown silt loam.

This soil is well suited to row crops and can be used intensively for that purpose. It is generally not so wet as Colo silty clay loam, which has no overwash, but it benefits from artificial drainage. Because the surface layer is silt loam, plowing is easier on this soil than on other Colo soils, and preparation of the seedbed is easier. Diversion terraces constructed on soils upslope protect this soil from siltation. Capability unit IIw-1; woodland suitability group 9.

Colo silty clay loam (133).—This soil is nearly level on flood plains and in narrow upland drainageways. It is associated with other bottom-land soils such as Spillville and Kennebec. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of soils that contain more clay in the subsoil than this soil, and they are a little wetter and do not drain so well. These soils commonly are in depressions or potholes, and drainage is a severe limitation to their use. Open ditches are needed in some places to remove surface water, because tile drainage does not function properly because of the fine-textured subsoil. Also included are areas of soils where the surface layer is thinner and darker colored than that of this soil.

This soil is suited to intensive row crops if it is drained and protected from flooding. Areas that are frequently flooded are used mainly for pasture. This soil is wet as

a result of flooding, slow runoff, or a high water table. Plowing is difficult and is delayed at times because of excessive moisture. The soil puddles readily when wet and becomes cloddy and hard when dry. It generally is plowed in fall, when moisture conditions are more favorable. Capability unit IIw-1; woodland suitability group 9.

Colo-Ely complex, 2 to 5 percent slopes (11B).—This complex consists of about 50 percent Colo soils, about 30 percent Ely soils, and about 20 percent Judson soils. These soils are poorly drained to somewhat poorly drained. They are along small streams on uplands. They are commonly associated with more sloping upland soils that are covered by loess. The Colo soils are nearer the stream channels or waterways and are bordered by a band of Ely soils. The Judson soils are above these two soils and border them.

Included with these soils in mapping are areas of soils that have deposits of light-colored overwash 6 to 20 inches thick.

Most areas of these soils are cropped along with surrounding soils, because individual areas generally are too small to be cropped separately and because these areas are narrow and irregular in shape. The soils in this complex are generally wet because of overflow and seepage from more sloping soils. Drainageways that have a high concentration of water need to be maintained in grass to help prevent gullying. Tile drainage is needed on each side of some drainageways to remove the excess water. Capability unit IIw-1; woodland suitability group 9.

Dickinson Series

The Dickinson series consists of well-drained to somewhat excessively drained soils that formed in 24 to 36 inches of sandy loam and underlying loamy sand and sand. These soils are nearly level to strongly sloping and are on uplands and on stream benches. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown to very dark grayish-brown fine sandy loam about 19 inches thick. The subsoil is brown to dark yellowish-brown, very friable sandy loam that extends to a depth of 33 inches. The substratum is dark yellowish-brown to yellowish-brown loamy fine sand that grades to fine sand.

Dickinson soils have moderately rapid to rapid permeability and low available water capacity. These soils are low in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 2 or 3 years.

These soils are suited to row crops if they are properly managed, but production depends on the amount and timeliness of rain. They are subject to both soil blowing and water erosion if vegetation is sparse.

Representative profile of Dickinson fine sandy loam, 2 to 5 percent slopes, in a north-facing area in a cultivated field, 186 feet west and 480 feet north of the southwest corner of NW¼NW¼ sec. 15, T. 85 N., R. 6 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) fine sandy loam; weak cloddy, breaking to very weak, fine, granular structure; very friable; neutral; abrupt boundary.

A12—6 to 15 inches, very dark brown (10YR 2/2) fine sandy loam; weak, very fine, granular structure; very friable; medium acid; gradual boundary.

A3—15 to 19 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; gradual boundary.

B1—19 to 28 inches, brown (10YR 4/3) fine sandy loam; weak, medium, subangular blocky structure; very friable; medium acid; gradual boundary.

B2—28 to 33 inches, dark yellowish-brown (10YR 4/4) sandy loam; very weak, fine, subangular blocky structure; very friable; medium acid; gradual boundary.

C1—33 to 44 inches, dark yellowish-brown (10YR 4/4) loamy fine sand; single grain; loose; medium acid; gradual boundary.

C2—44 to 78 inches, yellowish-brown (10YR 5/6) fine sand; single grain; loose; medium acid.

The solum ranges from 24 to 40 inches in thickness. Depth to loamy sand and sand is commonly 24 to 36 inches, and sand particles are dominantly fine and medium in size. The A horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2) in color and from 10 to 20 inches in thickness. The B horizon ranges from dark brown (10YR 3/3) to brown (10YR 4/3) in the upper part to dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4, 5/6) in the lower part. The C horizon ranges from loamy sand to fine sand. Reaction ranges from slightly acid to strongly acid in the most acid part of the solum.

Dickinson soils formed in material similar to that in which Lamont and Sparta soils formed. They are associated with Bertram, Kenyon, Olin, and Tama soils. They contain less sand in the A and B horizons than Sparta soils and typically have a thicker, darker colored A horizon than Lamont soils. They contain more sand in the lower horizons than Kenyon and Olin soils, and they do not have glacial till in the lower part of the solum. They are not underlain by limestone bedrock, as are Bertram soils. They contain more sand throughout the profile than Tama soils.

Dickinson fine sandy loam, 0 to 2 percent slopes (175A).—This soil is on uplands and on stream benches. On uplands it is commonly associated with Kenyon and Sparta soils and more sloping Dickinson soils; on stream benches it is commonly adjacent to Flagler, Saude, and Sparta soils. The surface layer is very dark brown to very dark grayish-brown, very friable fine sandy loam about 20 inches thick. It is generally free of gravel, but in some areas small amounts are at a depth of less than 40 inches.

Included with this soil in mapping are small areas, especially on stream benches, where gravelly sand is below a depth of 40 inches.

This soil is suited to row crops, and production can be good if rain is normal and timely. It is somewhat excessively drained and is droughty in some years. It is subject to soil blowing if it is cultivated. Capability unit IIIs-1; woodland suitability group 3.

Dickinson fine sandy loam, 2 to 5 percent slopes (175B).—This soil is in convex areas on uplands and stream benches. On uplands it is commonly associated with Kenyon, Olin, and Sparta soils and other Dickinson soils; on stream benches it is adjacent to Flagler and Sparta soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of soils that contain some gravel below a depth of 40 inches.

This soil is suited to row crops and production can be good if rain is normal and timely. It is somewhat excessively drained and is droughty. It is subject to slight

soil blowing and water erosion if it is cultivated. Capability unit IIIe-3; woodland suitability group 3.

Dickinson fine sandy loam, 5 to 9 percent slopes (175C).—This soil is on convex ridges on uplands and stream benches. It is commonly associated with Bertram, Kenyon, Olin, and Sparta soils and less sloping Dickinson soils. The surface layer is very dark brown to very dark grayish-brown very friable fine sandy loam about 12 to 16 inches thick.

Included with this soil in mapping are areas of moderately eroded soils that are lower in fertility and content of organic matter than this Dickinson soil.

This soil is suited to row crops, and production can be good if rain is normal and timely. It is somewhat excessively drained and is droughty. It is subject to slight soil blowing and water erosion if it is cultivated. Capability unit IIIe-3; woodland suitability group 3.

Dickinson fine sandy loam, 9 to 14 percent slopes (175D).—This soil is on side slopes and ridges on uplands and stream benches. It is commonly associated with Kenyon, Olin, and Sparta soils and less sloping Dickinson soils. The surface layer is very dark brown to very dark grayish-brown fine sandy loam that is 10 to 16 inches thick.

Included with this soil in mapping are areas of eroded soils that are lower in fertility and content of organic matter than this Dickinson soil. Also included are a few small areas of soils where slope is steeper than 14 percent, and a few areas that have glacial till at a depth of about 40 inches.

This soil is excessively drained and droughty. It is not well suited to row crops, and production depends on the amount and timeliness of rain. It is subject to slight soil blowing and water erosion. It is better suited to hay and pasture than to row crops. Capability unit IVe-2; woodland suitability group 3.

Dickinson fine sandy loam, loam substratum, 2 to 5 percent slopes (409B).—This soil is in convex areas on uplands. It is commonly associated with Kenyon, Olin, and Sparta soils and other Dickinson soils. The surface layer is very dark brown to very dark grayish brown very friable sandy loam about 20 inches thick. The subsoil is brown sandy loam that extends to a depth of about 40 inches and is underlain by loam glacial till.

Included with this soil in mapping are small areas of nearly level soils and areas of soils where underlying glacial till is at a depth of more than 50 inches.

This soil is suited to row crops, and production can be good if rain is normal and timely. It is droughty at times during years of below-normal rain, and it is subject to slight soil blowing and water erosion if it is cultivated. At times it is seepy in spring or after periods of heavy rain. Capability unit IIIe-3; woodland suitability group 3.

Dickinson fine sandy loam, loam substratum, 5 to 9 percent slopes (409C).—This soil is in convex areas adjacent to drainageways or is on mounds on uplands. It is commonly below other less sloping Dickinson sandy loams. It is commonly associated with Kenyon, Olin, and Sparta soils and other Dickinson soils. Loam glacial till Dickinson soil. Also included are small areas of soils where depth to till is less than 36 inches or is more than 50 inches.

This soil is suited to row crops, and production can be good if rain is normal and timely. In places it is droughty during years of below-normal rain. It is subject to soil blowing and water erosion if it is cultivated, and in places it is seepy in spring or after periods of heavy rain. Capability unit IIIe-3; woodland suitability group 3.

Dickinson-Sparta-Tama complex, 5 to 9 percent slopes (442C).—This complex is on ridgetops and side slopes on uplands. The ridgetops are mainly on long, narrow upland ridges that are oriented from northwest to southeast. It consists of sandy and silty soils that formed in wind-blown material. It consists of about 40 percent Dickinson soils, 30 percent Sparta soils, and 30 percent Tama soils.

These soils are moderately well suited to row crops if they are well managed. Production depends on the amount and timeliness of rain. These soils are subject to erosion, and the sandy soils are droughty. Terraces are difficult to construct and maintain in the sandy areas. Capability unit IIIe-3; woodland suitability group 2.

Dickinson-Sparta-Tama complex, 9 to 14 percent slopes (442D).—This complex consists of sandy and silty soils that formed in wind-blown material. These soils are on uplands. This complex is about 40 percent Dickinson soils, about 30 percent Sparta soils, and about 30 percent Tama soils.

Included with these soils in mapping are small areas of moderately eroded soils that are lower in content of organic matter than the soils in as this complex.

These soils are not well suited to row crops. They are better suited to hay or pasture. Production depends on the amount and timeliness of rain. These soils are subject to erosion if they are cultivated, and in places they are droughty. Terraces are difficult to construct and maintain because of the variety of soils and the irregular slopes. Capability unit IVe-2; woodland suitability group 2.

Dinsdale Series

The Dinsdale series consists of gently sloping to moderately sloping, moderately well drained and well drained soils on uplands. Slopes are convex. These soils formed in loess and underlying glacial till. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silty clay loam about 14 inches thick. The subsoil extends to a depth of 48 inches. It is dark-brown and brown medium silty clay loam to a depth of about 27 inches. Below this it is yellowish-brown loam that has strong-brown and grayish-brown mottles. The substratum is yellowish-brown, mottled sandy clay loam.

Dinsdale soils have high available water capacity and moderate permeability in the upper part of the profile and moderately slow permeability in the lower part.

These soils are well suited to row crops.

Representative profile of Dinsdale silty clay loam, 2 to 5 percent slopes, in a cultivated field, 10 feet east and 445 feet north of the southwest corner of NW¼ NW¼ sec. 11, T. 82 N., R. 6 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) light silty clay loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; clear boundary.

A12—6 to 11 inches, very dark brown (10YR 2/2) light silty clay loam; weak, fine, granular and weak, fine, subangular blocky structure; friable; neutral; gradual boundary.

A3—11 to 14 inches, very dark grayish-brown (10YR 3/2) light silty clay loam, dark brown (10YR 3/3) when crushed; moderate, fine, subangular blocky structure; friable; slightly acid; gradual boundary.

B1—14 to 18 inches, dark-brown (10YR 3/3) medium silty clay loam, brown (10YR 4/3) when crushed; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B2t—18 to 27 inches, brown (10YR 4/3) medium silty clay loam; moderate, fine, subangular blocky structure; friable; few, thin, discontinuous clay films; medium acid; clear boundary.

IIB22t—27 to 35 inches, yellowish-brown (10YR 5/4) light loam; few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; friable; few, thin, discontinuous clay films; discontinuous, light-gray (10YR 7/1, dry), grainy coatings on vertical faces; discontinuous band of pebbles at a depth of 27 to 29 inches; medium acid; gradual boundary.

IIB31t—35 to 48 inches, yellowish-brown (10YR 5/6) heavy loam; brown (10YR 5/3) ped exteriors; common, fine, distinct, grayish-brown (10YR 5/2) mottles; weak, medium, prismatic structure; firm; few, thin, discontinuous clay films; nearly continuous, light-gray (10YR 7/2, dry), grainy coatings on vertical faces; few, faint, black oxide concretions; medium acid; gradual boundary.

IIC—48 to 60 inches, yellowish-brown (10YR 5/6) sandy clay loam; common, fine, distinct, light-gray (10YR 6/1) mottles; weak, coarse, prismatic structure; firm; slightly acid.

The solum typically is about 50 inches thick but ranges from about 40 to 60 inches in thickness. The loess typically is 24 to 40 inches thick but ranges from about 20 to 42 inches in thickness. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), and very dark grayish brown (10YR 3/2). It ranges from 10 to 20 inches in thickness in uneroded areas. The upper part of the B horizon formed in loess. It is dark brown (10YR 3/3), brown (10YR 4/3), and dark yellowish brown (10YR 4/4), and the clay content ranges from about 29 to 34 percent. The lower part of the B horizon and the C horizon formed in glacial till. These horizons have a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 4 to 8. They have few to common mottles that have a value of 4 to 6 and a chroma of 1 or 2. These horizons typically are loam but range to sandy clay loam and light clay loam. In places a layer of sandy loam or loamy sand, as much as 10 inches thick, is between the loess and the glacial till. Reaction is medium acid to strongly acid in the most acid part of the solum. Carbonates are at a depth of about 45 to 65 inches.

Dinsdale soils formed in material similar to that in which Franklin, Klinger, Maxfield, and Waubeek soils formed, and they are associated with Kenyon and Tama soils. They have a thicker, darker colored A horizon than Waubeek soils. They formed in loess and glacial till, but the Tama soils have a solum that formed entirely in loess. Dinsdale soils have a browner B horizon and are better drained than Franklin, Klinger, and Maxfield soils. They contain less sand in the upper part of the profile and are deeper to glacial till than Kenyon soils.

Dinsdale silty clay loam, 2 to 5 percent slopes (377B).—This soil is in convex areas on uplands. It is commonly associated with Klinger and Tama soils and more sloping Dinsdale soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are spots of sand and areas of glacial till outcrops, which are shown on the soil map by special symbols. The sandy areas are droughty and less productive than this soil, and the glacial till areas are less productive and have poorer tilth.

This soil is well suited to row crops, but if it is cultivated, it is subject to slight erosion. Terrace cuts should be minimized to avoid exposing the glacial till subsoil, which is low in fertility. Capability unit IIe-1; woodland suitability group 4.

Dinsdale silty clay loam, 5 to 9 percent slopes (377C).—This soil is in convex areas on uplands. It is commonly associated with Kenyon and Tama soils and is below less sloping Dinsdale soils. The profile of this soil is similar to the one described as representative for the series, but the dark surface layer is not so thick and glacial till is at a shallower depth in places.

Included with this soil in mapping are spots of sand and areas of till outcrops, which are indicated on the soil map by special symbols. The sandy areas are droughty and less productive than this soil, and the till areas are lower in fertility.

This soil is suited to row crops if it is properly managed, but it is subject to erosion if it is cultivated. In most places slopes are long and smooth and are suited to terrace construction. Terrace cuts should be minimized to avoid exposing the glacial till subsoil, which is lower in fertility. Capability unit IIIe-1; woodland suitability group 4.

Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded (377C2).—This soil is in convex areas on uplands. It is commonly associated with Tama and Kenyon soils and generally is below less sloping Dinsdale soils. This soil has a profile similar to the one described as representative for the series, but erosion has removed part of the surface layer. This soil is lower in content of organic matter and in fertility than the uneroded Dinsdale soils. This soil puddles at times during intense rains, resulting in increased rate of runoff. It becomes cloddy if it is worked when wet.

Included with this soil in mapping are spots of sand and areas of glacial till outcrops, which are indicated on the soil map by special symbols. The sandy areas are droughty and less productive than this soil, and the glacial till areas are less productive and lower in fertility.

This soil is suited to row crops, but it is subject to further erosion if it is cultivated. It needs more fertilizer than uneroded Dinsdale soils. Terrace cuts should be minimized to avoid exposing the glacial till subsoil, which is low in fertility. Capability unit IIIe-1; woodland suitability group 4.

Dodgeville Series

The Dodgeville series consists of well-drained soils that formed in 30 to 40 inches of loess and a thin layer of clayey residuum underlain by hard limestone bedrock.

These soils are gently to moderately sloping and are on convex uplands and in high benchlike areas. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown, heavy silt loam that grades to light silty clay loam. It is about 14 inches thick. The upper part of the subsoil is dark-brown to dark yellowish-brown, friable silty clay loam about 20 inches thick. A thin layer of mottled strong-brown and weak-red, firm silty clay is at a depth of 34 inches. The substratum, at a depth of 37 inches, is partially weathered limestone and shattered bedrock.

Dodgeville soils have moderate available water capacity and permeability. These soils are low to medium in available nitrogen and phosphorus and medium in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops, but unless rain is timely they tend to be droughty. Erosion is a major hazard.

Representative profile of Dodgeville silt loam, deep, 2 to 5 percent slopes, in a cultivated field, 770 feet north and 65 feet west of the southeast corner of NW¼NW¼ sec. 32, T. 84 N., R. 8 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; clear boundary.

A12—8 to 14 inches, very dark brown (10YR 2/2) light silty clay loam; very dark grayish-brown (10YR 3/2) ped exteriors; weak, fine, granular structure; friable; medium acid; gradual boundary.

B1—14 to 18 inches, dark-brown (10YR 3/3) light silty clay loam; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21t—18 to 28 inches, brown (10YR 4/3) silty clay loam; moderate, medium, subangular blocky structure; friable; strongly acid; gradual boundary.

B22t—28 to 34 inches, dark yellowish-brown (10YR 4/4) silty clay loam; few, fine, faint, grayish-brown (10YR 5/2) mottles in lower part of horizon; moderate, medium, subangular blocky structure; friable; few, thin, discontinuous, dark-brown (10YR 3/3) clay films; few, thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; medium acid; abrupt boundary.

IIB3t—34 to 37 inches, mottled strong-brown (7.5YR 5/6) and weak-red (2.5YR 5/2) silty clay; medium, fine, subangular blocky structure; firm; continuous clay films; slightly acid; abrupt boundary.

IIR—37 inches, limestone flagstone and shattered limestone bedrock; dark reddish-brown (5YR 3/4) silty clay between flagstones.

Thickness of the solum and depth to limestone bedrock range from 30 to 40 inches. The A horizon has a hue of 10YR, a value of 2 or 3, and a chroma of 1 or 2. It ranges from 10 to 16 inches in thickness. The B2 horizon has a hue of 10YR, a value of 3 to 5, and a chroma of 3 to 6. It ranges from heavy silt loam to silty clay loam. The IIB horizon, which formed in residuum weathered from limestone, is 2 to 6 inches thick and is clay or silty clay. The clayey residuum is thinner than the defined range for the series.

Dodgeville soils are closely associated with Dinsdale and Tama soils. Dodgeville soils are underlain by limestone at a depth of 30 to 40 inches, but Dinsdale and Tama soils are not.

Dodgeville silt loam, deep, 2 to 5 percent slopes (204B).—This soil is on side slopes on uplands and in benchlike areas. It is associated with more sloping Dodgeville soils and commonly is downslope from Dinsdale and Tama soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of soils in which loess is underlain by limestone bedrock at a depth of less than 30 inches. In places limestone outcrops are on the surface, and these areas are indicated on the soil map by a special symbol.

This soil is suited to row crops if it is properly managed, but it is droughty unless rainfall is timely. It is subject to erosion if it is cultivated. Terrace construction is difficult in some areas because of shallowness to bedrock. Capability unit IIe-1; woodland suitability group 4.

Dodgeville silt loam, deep, 5 to 9 percent slopes (204C).—This soil is on convex side slopes on uplands or in high benchlike areas. It is below less sloping Dodgeville soils and is commonly associated with Dinsdale, Tama, or Waubeek soils. The profile of this soil is similar to the one described as representative for the series, but depth to limestone bedrock is a little shallower.

Included with this soil in mapping are a few areas of soils in which loess is underlain by limestone bedrock at a depth of less than 30 inches. In some places limestone outcrops are on the surface, and these areas are indicated on the soil map by a special symbol. Also included are small areas of moderately eroded soils in which the plow layer is a mixture of the material originally in the surface layer and that in the subsoil. These eroded soils are lower in content of organic matter than this Dodgeville soil.

This soil is suited to row crops, but it is droughty unless rain is timely. It is subject to erosion if it is cultivated. Terrace construction is difficult in some areas because of the shallowness to bedrock. Capability unit IIIe-1; woodland suitability group 4.

Donnan Series

The Donnan series consists of moderately well drained to somewhat poorly drained soils that formed in 20 to 40 inches of loamy material and underlying, very firm, fine-textured, weathered glacial till. These soils are gently sloping to moderately sloping and are on convex side slopes and crests of ridges on uplands.

In a representative profile the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is dark grayish-brown loam about 5 inches thick. The subsoil is about 66 inches thick. The upper 14 inches is light olive-brown, mottled clay loam and silty clay loam. The lower 52 inches is gray and olive-gray, very firm clay.

Donnan soils have moderate permeability in the upper part of the profile and very slow permeability in the lower part. They have high available water capacity. They are low in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

In most years these soils are suited to row crops, but because of the difference in permeability in the upper and lower parts of the profile, these soils are seasonally seepy and wet. They dry out slowly in spring and cannot be cultivated soon after rain.

Representative profile of Donnan loam, 2 to 5 percent slopes, in a permanent pasture, 46 feet south and 53 feet east of the northwest corner of SW¼NW¼ sec. 36, T. 86 N., R. 8 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—7 to 12 inches, dark grayish-brown (10YR 4/2) loam; very dark gray (10YR 3/1) on plates; weak, fine, granular structure that tends to be platy; friable; neutral; clear boundary.

B1—12 to 18 inches, light olive-brown (2.5Y 5/4) clay loam; grayish-brown (2.5Y 5/2) ped exteriors; moderate, fine, subangular blocky structure; firm; strongly acid; gradual boundary.

B21t—18 to 26 inches, light olive-brown (2.5Y 5/4) silty clay loam; grayish-brown (2.5Y 5/2) ped exteriors; moderate, fine, subangular blocky structure; firm; thin discontinuous clay films; few, thin, discontinuous, light-gray (10YR 7/2), grainy coatings on peds; medium acid; clear boundary.

IIB22bt—26 to 37 inches, gray (5Y 5/1) clay; moderate, very fine, subangular blocky structure; very firm; thick continuous clay films; slightly acid; gradual boundary.

IIB23bt—37 to 78 inches, olive-gray (5Y 5/2) and olive (5Y 5/3) clay; weak, fine, subangular blocky structure; very firm; thick continuous clay films; numerous quartz particles that increase as depth increases; slightly acid.

The solum ranges from 50 inches to more than 80 inches in thickness. Where the solum formed in loamy material, it merges with a buried paleosol; therefore, the thickness of the solum varies. The loamy overburden over the buried soil ranges from 20 to 40 inches in thickness. The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 8 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). It is 2 to 5 inches thick. In places the A2 horizon is incorporated into the Ap horizon. The A horizon ranges from loam or silt loam to light clay loam or gritty silty clay loam. The upper part of the B horizon has a hue of 10YR or 2.5Y, a value of 4 or 5, and a chroma of 3 or 4. Mottles that have a chroma of 1 or 2 are present in places. The upper part of the B horizon is clay loam or loam but ranges to silty clay loam. The IIB horizon formed in a clay or silty clay paleosol. It has a hue of 5Y or 2.5Y, a value of 5 or 6, and a chroma of 1 to 3. Higher chroma mottles are common in places. Reaction is medium acid to strongly acid in the most acid part of the solum.

Donnan soils are associated with Bassett, Dinsdale, Franklin, Kenyon, Oran, and Schley soils. They are underlain by a clayey paleosol at a depth of 20 to 40 inches, but Bassett, Dinsdale, Franklin, Kenyon, Oran, and Schley soils are not.

Donnan loam, 2 to 5 percent slopes (782B).—This soil is on ridges and convex side slopes. It is commonly associated with Bassett, Dinsdale, Franklin, Kenyon, Oran, and Schley soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of soils where the depth to gray clay (gumbotil) is less than 20 inches or slightly more than 40 inches. Also included are a few areas of soils that have a sandy surface layer. These areas are indicated on the soil map by a special symbol.

This soil is moderately well suited to row crops. It is subject to slight erosion if it is cultivated. Most areas are cultivated, and land use is commonly determined by the use of surrounding soils.

Practices to control erosion on this soil slow down movement of surface water and let more water soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. Consequently, a combination of terracing and tile drainage is needed in places. Careful placement of tile is very important because of very slow permeability in the underlying subsoil, and tile drainage does not drain all areas satisfactorily. If the clayey subsoil is deep enough, tile can be placed above this layer with satisfactory results. Capability unit IIe-3; woodland suitability group 7.

Donnan loam, 5 to 9 percent slopes, moderately eroded (782C2).—This soil is on ridges and convex side slopes. It is commonly associated with Bassett, Dinsdale, Kenyon, and Schley soils. This soil has a profile similar to the one described as representative for the series, but erosion has removed part of the dark-colored surface layer, and this soil is lower in organic matter than uneroded Donnan soils.

Included with this soil in mapping are areas of severely eroded soils where the clayey subsoil is exposed at the surface in places. These soils are lower in content of organic matter and in fertiliy than this Donnan soil. These areas are shown on the soil map by a special symbol. Also included are areas of soils that have a sandy surface layer. These soils have a high infiltration rate and in wet seasons are very seepy, but at other times they are droughty.

This soil is moderately well suited to row crops. The difference in permeability of the overburden of and the clay subsoil results in water accumulating above the clay subsoil. This results in a perched water table and seepy areas on the side slopes. If the clay subsoil is deep enough to provide adequate cover for tile, this soil should be tiled across the slopes to intercept seepage.

Practices to control further erosion on this soil slow down movement of surface water and let more water soak into the soil. The extra water complicates drainage. Consequently, a combination of drainage and erosion control practices is most likely to be successful. Because of very slow permeability in the subsoil, careful placement of tile is important. Capability unit IIIe-1; woodland suitability group 7.

Donnan loam, gray subsoil variant (0 to 2 percent slopes) (772).—This soil is in swales on upland flats. It is commonly associated with Franklin, Kenyon, Klinger, and Maxfield soils and other Donnan soils. This soil has a profile similar to the one described as representative for the series, but the upper part of the subsoil is grayer. This soil is more poorly drained than other Donnan soils.

Included with this soil in mapping are a few areas of soils in which the clay subsoil is at a depth of as much as 48 inches. Also included are small areas of soils on stream benches.

This soil is suited to row crops if it is drained. Drainage is needed because permeability is moderate in the overburden and very slow in the fine-textured subsoil and water accumulates above the subsoil. Surface drainage is beneficial because water tends to pond. For satisfactory drainage, tiles need to be closer together than in most other poorly drained soils in the county. Even if this soil is artificially drained, field operations are commonly delayed. Areas that are not drained are generally in permanent pasture. Capability unit IIIw-2; woodland suitability group 9.

Downs Series

The Downs series consists of well-drained soils that formed in loess more than 40 inches thick. These soils are gently sloping to strongly sloping and are on upland ridges and side slopes. They formed under prairie grasses and timber.

In a representative profile the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish-brown silt loam about 4 inches thick. The subsoil extends to a depth of 60 inches. The upper part is brown silt loam. The lower part is dark yellowish-brown to yellowish-brown silty clay loam that grades to yellowish-brown silt loam. The substratum is yellowish-brown, friable silt loam.

Downs soils have moderate permeability and high available water capacity. They are moderate to low in content of organic matter. They are low in available nitrogen, low to medium in available phosphorus, and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops and generally are used for this purpose. Concerns of management are control of erosion and maintenance of fertility.

Representative profile of Downs silt loam, 2 to 5 percent slopes, in a northeast-facing area in a cultivated field. 200 feet west and 300 feet south of the northeast corner of NW¼SE¼ sec. 21, T. 83 N., R. 5 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam, slightly higher chroma when kneaded; cloddy, breaking to weak, fine, granular structure; friable; slightly acid; abrupt boundary.

A2—7 to 11 inches, dark grayish-brown (10YR 4/2) silt loam; very dark grayish-brown (10YR 3/2) ped exteriors; thick, platy structure breaking to weak, fine, subangular blocky structure; friable; slightly acid; clear boundary.

B1—11 to 15 inches, brown (10YR 4/3) heavy silt loam; dark-brown (10YR 3/3) ped exteriors; weak, fine, subangular blocky structure; friable; very few, light-gray (10YR 7/1, dry), grainy coatings; slightly acid; gradual boundary.

B21t—15 to 23 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; brown (10YR 4/3) ped exteriors; moderate, fine to medium, subangular blocky structure; friable; thin discontinuous clay films; few, light-gray (10YR 7/1, dry), grainy coatings; strongly acid; gradual boundary.

B22t—23 to 34 inches, yellowish-brown (10YR 5/4) light silty clay loam; dark yellowish-brown (10YR 4/4) ped exteriors; moderate, medium, subangular blocky structure; friable; thin discontinuous clay films; discontinuous, light-gray (10YR 7/1, dry), grainy coatings; strongly acid; gradual boundary.

B31t—34 to 45 inches, yellowish-brown (10YR 5/4) light silty clay loam; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; friable; thin discontinuous clay films; few, discontinuous, light-gray (10YR 7/1, dry), grainy coatings; few, dark-brown, oxide concretions; numerous clay-filled pores; strongly acid; gradual boundary.

B32t—45 to 60 inches, yellowish-brown (10YR 5/4) silt loam; few, fine, faint, light brownish-gray (10YR 6/2) and light-gray (10YR 7/2) mottles; weak, coarse, prismatic structure; discontinuous clay films; discontinuous, light-gray (10YR 7/1, dry), grainy coatings; friable; many dark-brown oxide concretions; many clay-filled pores; medium acid; gradual boundary.

C—60 to 64 inches, yellowish-brown (10YR 5/4) silt loam; massive; friable; fine, faint, light brownish-gray (10YR 6/2) and strong-brown (7.5YR 5/6) mottles; many dark-brown oxide concretions; medium acid.

The solum ranges from 50 to 70 inches in thickness. The A1 horizon, where present, is very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). It ranges from 6 to 10 inches in thickness. The A2 horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3). It ranges from 2 to 4 inches in thickness. In some areas the A2 horizon is incorporated wholly into the Ap horizon. The upper part of the B horizon commonly is dark brown (10YR 3/3) or brown (10YR 4/3) and grades to a value of 4 or 5 and a chroma of 4 to 6 as depth increases. The finest textured part of the B horizon is light to medium silty loam, and the clay content ranges from 30 to 35 percent. Low-chroma mottles typically are below a depth of 36 inches. Reaction is medium acid to very strongly acid in the most acid part of the solum.

Downs soils formed in material similar to that in which Fayette and Tama soils formed, and they are associated with Waubeek soils. Downs soils have a thicker, darker colored A horizon than Fayette soils but a thinner, lighter colored A horizon than Tama soils. They differ from Waubeek soils in being free of glacial till in the lower part of the solum that is characteristic of Waubeek soils.

Downs silt loam, 2 to 5 percent slopes (162B).—This soil is on upland ridges or broad divides. Areas of steeper Downs, Fayette, and Waubeek soils are downslope. The profile of this soil is the one described as representative for the series.

This soil is well suited to corn and soybeans. In most places this soil is well suited to contouring and terracing because of the long, uniform slopes. It is subject to slight erosion if it is cultivated. Capability unit IIe-1; woodland suitability group 4.

Downs silt loam, 5 to 9 percent slopes (162C).—This soil is on narrow ridgetops and side slopes on uplands. It is above or below areas of other Downs soils. This soil has the profile described as representative of the series, but in uncultivated areas the surface layer is very dark gray to very dark brown silt loam about 5 to 8 inches thick. Also, the subsurface layer is distinct and lighter colored. In cultivated areas the plow layer typically is very dark grayish-brown silt loam about 6 to 8 inches thick.

Included with this soil in mapping are a few areas of soils where the surface layer is thicker and darker colored than that of this soil, and the content of organic matter is higher.

This soil is suited to row crops, but it is subject to erosion if it is cultivated. Capability unit IIIe-1; woodland suitability group 4.

Downs silt loam, 5 to 9 percent slopes, moderately eroded (162C2).—This soil is on the top of divides or on convex side slopes on uplands. It has a profile similar to the one described as representative for the series, but the surface layer is lighter colored and some of the original subsoil is mixed into it.

Most of this soil is used for crops. It is suited to this use, but it is subject to further erosion if it is cultivated. It is lower in content of organic matter and in available nitrogen than uneroded Downs soils. It generally has good tilth but puddles and becomes cloddy if it is worked when wet. Capability unit IIIe-1; woodland suitability group 4.

Downs silt loam, 9 to 14 percent slopes (162D).—This soil is on the convex side slopes below the less sloping Downs soils and above more sloping Fayette soils. In cultivated areas the plow layer is very dark grayish brown. In wooded areas and in areas used for permanent

pasture, the surface layer is very dark brown or very dark gray.

Although some areas of this soil are in pasture and woodland, this soil is suited to occasional cropping. It is subject to erosion if it is cultivated. Capability unit IIIe-2; woodland suitability group 4.

Downs silt loam, 9 to 14 percent slopes, moderately eroded (162D2).—This soil is mainly on side slopes below less sloping Downs soils and above more sloping Fayette soils. The plow layer is very dark grayish-brown to dark-brown silt loam, and some of the original subsoil is mixed into it.

This soil is suited to occasional row crops, but it is subject to further erosion if it is cultivated. It is lower in content of organic matter and in available nitrogen than uneroded Downs soils. It generally has good tilth but puddles and becomes cloddy if it is worked when wet. Capability unit IIIe-2; woodland suitability group 4.

Ely Series

The Ely series consists of somewhat poorly drained soils that formed in sediment washed down from loess-covered adjacent hillsides. These soils are gently sloping on foot slopes and fans where waterways empty into the bottom lands. The native vegetation was prairie grasses.

In a representative profile the surface layer is about 29 inches thick. It is very dark brown silt loam in the upper 7 inches. It grades to black and very dark gray light silty clay loam in the lower part. The subsoil is dark grayish-brown light silty clay loam in the upper part and mottled yellowish-brown and grayish-brown light silty clay loam in the lower part.

Ely soils have moderate permeability and high available water capacity. They are low to medium in available nitrogen and very low in available phosphorus and potassium. These soils commonly are slightly acid where they have not been limed within the last 5 years.

These soils are well suited to row crops if they are properly managed. Because seepage from the uplands keeps these soils wet, tile drainage is needed in some places. In some places siltation from higher lying eroded, sloping soils is a concern.

Representative profile of Ely silt loam, 2 to 5 percent slopes, in a cultivated field, 740 feet north and 650 feet west of the southeast corner of SE¼NW¼ sec. 2, T. 82 N., R. 6 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam; cloddy, breaking to moderate, fine, granular structure; friable; neutral; abrupt boundary.

A12—7 to 21 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; neutral; clear boundary.

A3—21 to 29 inches, very dark gray (10YR 3/1) light silty clay loam, very dark grayish brown (10YR 3/2) when kneaded; weak, medium, subangular blocky structure breaking to moderate, fine, granular structure; friable; slightly acid; clear boundary.

B2—29 to 43 inches, dark grayish-brown (10YR 4/2) light silty clay loam; very dark grayish-brown (10YR 3/2) ped exteriors; common, fine, distinct, yellowish-brown (10YR 5/6) mottles and few, fine, distinct, light-gray (2.5Y 7/2) mottles; weak, medium, subangular blocky structure; friable; few, thin, discontinuous, very dark grayish-brown (10YR 3/2) clay films on vertical cleavage faces; neutral; gradual boundary.

B3—43 to 71 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) light silty clay loam; moderate, medium, prismatic structure; friable; few dark-brown (7.5YR 4/4) oxide concretions; slightly acid.

The solum commonly is more than 48 inches thick but ranges from 40 inches to more than 70 inches in thickness. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). Color that has a value of 3 extends to a depth of 24 to 36 inches. The A horizon is silt loam or light silty clay loam. The B horizon typically is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2), but in places the lower part is higher in chroma but has low-chroma mottles. The B horizon ranges from light to medium silty clay loam and is about 30 to 35 percent clay. Reaction typically is slightly acid to medium acid in the most acid part of the solum, but in places it is neutral throughout.

Ely soils formed in material similar to that in which Colo and Judson soils formed. They have a browner B horizon and are better drained than Colo soils. They have a grayer B horizon and are not so well drained as Judson soils.

Ely silt loam, 2 to 5 percent slopes (428B).—This soil is on footslopes or alluvial fans. It is commonly associated with Colo and Judson soils and is below Dinsdale, Downs, and Tama soils.

Included with this soil in mapping are small areas of soils that have 6 to 20 inches of light-colored silty overwash.

This soil is well suited to row crops if it is well managed. Because of seepage from adjacent areas, use of interceptor tile helps to remove this excess water. Areas of this soil are small, and in places their use is determined by that of the surrounding soils. Capability unit IIe-4; woodland suitability group 7.

Fayette Series

The Fayette series consists of well-drained soils that formed in loess more than 40 inches thick. These soils are mainly on ridges and side slopes on uplands, but there are small areas on benches adjacent to major streams. Most of the Fayette soils on uplands are along Cedar and Wapsipinicon Rivers and Buffalo Creek. Slopes range from 2 to 30 percent. Native vegetation was trees.

In a representative profile in an uncultivated area, the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is dark-gray to dark grayish-brown silt loam about 8 inches thick. The subsoil extends to a depth of about 48 inches and is brown to yellowish brown. It is silt loam in the upper part and silty clay loam in the lower part. The substratum is yellowish-brown, friable silt loam that has a few grayish-brown mottles.

Fayette soils are moderately permeable and have high available water capacity. The content of organic matter is low except in the top few inches of areas that are uncultivated. These soils are low in available nitrogen and potassium and high in available phosphorus. They are acid where they have not been limed within the last 5 years.

The less sloping areas of Fayette soils are suited to row crops. The steeper areas are better suited to pasture or woods.

Representative profile of Fayette silt loam, 2 to 5 percent slopes, in an east-facing area in a pasture, 26 feet east and 792 feet south of the north-west corner of NE¼NE¼ sec. 12, T. 82 N., R. 7 W.:

A1—0 to 4 inches, very dark gray (10YR 3/1) silt loam; weak, fine, granular structure; friable; slightly acid; clear boundary.

A21—4 to 7 inches, dark-gray (10YR 4/1) silt loam; some very dark gray (10YR 3/1) material from A1 horizon; weak, thin, platy structure; friable; slightly acid; clear boundary.

A22—7 to 12 inches, dark grayish-brown (10YR 4/2) silt loam; weak to moderate, thin, platy structure; friable; light-gray (10YR 7/1, dry), grainy coatings on peds; medium acid; clear boundary.

B1—12 to 18 inches, brown (10YR 5/3) heavy silt loam; brown ped exteriors; moderate, fine and medium, subangular blocky structure; friable; nearly continuous, light-gray (10YR 7/1, dry), grainy coatings on peds; medium acid; gradual boundary.

B21t—18 to 27 inches, yellowish-brown (10YR 5/4) light silty clay loam; dark yellowish-brown (10YR 4/4) ped exteriors; moderate, fine, subangular blocky structure; friable; thin discontinuous clay films and discontinuous, light-gray (10YR 7/1, dry), grainy coatings on peds; strongly acid; gradual boundary.

B22t—27 to 35 inches, dark yellowish-brown (10YR 4/4) medium silty clay loam; moderate, medium, subangular blocky structure; friable; thin discontinuous clay films and light-gray (10YR 7/1, dry), grainy coatings on peds; strongly acid; gradual boundary.

B3t—35 to 48 inches, yellowish-brown (10YR 5/4) light silty clay loam; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable; thin discontinuous clay films and light-gray (10YR 7/1, dry), grainy coatings; few dark-brown oxide concretions; strongly acid; gradual boundary.

C—48 to 70 inches, yellowish-brown (10YR 5/4) silt loam; few, fine, faint, grayish-brown (10YR 5/2) mottles; massive and has some vertical cleavage; clay accumulation in some root channels; strongly acid.

The solum ranges from 45 to 60 inches or more in thickness. The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 2 to 4 inches in thickness. In cultivated areas the Ap horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 4/3 or 5/3). The A2 horizon typically is dark grayish brown (10YR 4/2) but ranges to grayish brown (10YR 5/2) and brown (10YR 5/3). It ranges from 4 to 8 inches in thickness. In eroded areas the A2 horizon is incorporated wholly into the Ap horizon in places. The B2t horizon is 4 or 5 in value and ranges from 3 to 6 in chroma. Texture of the B2t horizon commonly is light to medium silty clay loam that has a clay content of 28 to 34 percent. Mottles that have a hue of 10YR or 2.5Y, a value of 5, and a chroma of 1 or 2 are present in the lower part of the B horizon and in the C horizon in some places. Depth to these grayish mottles generally decreases as slope gradient increases on convex slopes. Reaction is strongly acid to very strongly acid in the most acid part of the solum.

Fayette soils formed in material similar to that in which Downs, Seaton, and Tama soils formed. They have a thinner dark colored A horizon and a more distinct A2 horizon than Downs and Tama soils. They have more clay in the B horizon than Seaton soils.

Fayette silt loam, 2 to 5 percent slopes (163B).—This soil is on moderately wide ridgetops on uplands that are covered by loess. The profile of this soil is the one described as representative for the series. In wooded areas a thin layer of leaf litter is on the surface in places.

Included with this soil in mapping are small areas of Fayette silt loam that is nearly level and small areas of soils that have a thinner surface layer than this Fayette soil because of erosion.

This soil is well suited to corn and soybeans, but it is subject to erosion if it is cultivated. Capability unit IIe-1; woodland suitability group 4.

Fayette silt loam, 5 to 9 percent slopes (163C).—This Fayette soil is on convex side slopes and narrow ridgetops. In most places it is above more sloping Fayette soils. A few areas are on stream benches along Cedar River.

Most of this soil is in timber or is used for pasture. This soil is suited to corn and soybeans, but it is subject to erosion if it is cultivated. Most areas of this soil are suitable for terracing because of the uniform length and shape of the slopes. Capability unit IIIe-1; woodland suitability group 4.

Fayette silt loam, 5 to 9 percent slopes, moderately eroded (163C2).—This soil is on convex side slopes and narrow ridgetops. It is commonly above more sloping Fayette soils. This soil has a profile similar to the one described as representative for the series, but erosion has removed part of the surface and subsurface layers, and some of the brown to dark yellowish-brown subsoil is mixed into the plow layer, which is dark grayish brown. The plow layer is lighter in color when dry and is lower in content of organic matter and in fertility than that of uneroded Fayette soils. It becomes cloddy if worked when wet and puddles at times during intense rains, resulting in more runoff and retarded plant growth.

All of this soil was formerly cultivated or is now cultivated. This soil is suited to row crops but is erodible if it is cultivated. For good growth of crops, more fertilizer is needed on this soil than on Fayette soils that are not eroded. Most areas are suitable for terracing because of the uniform length and shape of the slopes. Capability unit IIIe-1; woodland suitability group 4.

Fayette silt loam, 9 to 14 percent slopes (163D).—This soil is on convex side slopes and on narrow ridgetops on uplands. It is below less sloping Fayette soils and above steeper Fayette and Sogn soils. A few areas are on stream benches. In uncultivated areas the surface layer is 2 to 4 inches of very dark gray silt loam. Also, in cultivated areas part or all of the original subsurface layer is mixed into the plow layer.

Included with this soil in mapping are some small areas of soils that have a thinner, lighter colored surface layer and are lower in content of organic matter than this Fayette soil.

Most of this soil is in timber or is used for pasture. This soil is suited to occasional row crops if it is properly managed. It is subject to erosion if it is cultivated. In most areas slopes are generally long and uniform and are well suited to conservation practices. Capability unit IIIe-2; woodland suitability group 4.

Fayette silt loam, 9 to 14 percent slopes, moderately eroded (163D2).—This soil is on convex side slopes and narrow ridgetops. It is below less sloping Fayette soils and above steeper Fayette and Sogn soils. A few areas are on stream benches. This soil has a profile similar to that described as representative for the series, except that erosion has removed part of the surface and subsurface layers. The dark grayish-brown plow layer is a mixture of material from the brown to dark yellowish-brown subsoil and the original surface layer. The

plow layer of this Fayette soil is much lighter in color when dry and lower in fertility and content of organic matter than that of uneroded Fayette soils. This soil becomes cloddy if it is worked when wet, and in places it puddles during intense rains, resulting in more runoff and retarded plant growth.

All of this soil was formerly cultivated or is now cultivated. For good growth of crops, more fertilizer is required on this soil than on uneroded Fayette soils. Slopes are generally long and uniform and are well suited to conservation practices and to occasional row crops. Capability unit IIIe-2; woodland suitability group 4.

Fayette silt loam, 9 to 14 percent slopes, severely eroded (163D3).—This soil is on short, convex side slopes or on long, somewhat uniform side slopes. The areas are dissected by a few gullies in places. This soil is below less sloping Fayette soils and above more sloping Fayette soils. It has a profile similar to the one described as representative for the series, but it is severely eroded and the present surface layer is commonly brown silt loam, but in places it is silty clay loam. This Fayette soil is lower in fertility and content of organic matter than uneroded Fayette soils. It puddles easily during intense rains, resulting in more runoff and retarded plant growth.

Included with this soil in mapping are a few areas of less eroded Fayette soils that are darker in color and higher in content of organic matter than this soil.

This soil can be used for occasional row crops, but it is better suited to hay and pasture. Capability unit IVe-1; woodland suitability group 4.

Fayette silt loam, 14 to 18 percent slopes (163E).—This soil is on long, convex side slopes that are dissected by waterways in places. It is below less sloping Fayette soils and above steeper Fayette and Sogn soils. In wooded areas this soil has a thin leaf litter covering the very dark gray silt loam surface layer. The silt loam subsurface layer is distinctly lighter in color than that in the profile described as representative for the series.

Included with this soil in mapping are a few areas of soils that have a thicker, darker colored surface layer and a higher content of organic matter than this Fayette soil.

Most of this soil is in timber or is used for pasture. It is better suited to hay and pasture than to row crops. It can be used for row crops when hay and pasture need renovating. Capability unit IVe-1; woodland suitability group 4.

Fayette silt loam, 14 to 18 percent slopes, moderately eroded (163E2).—This soil is on convex side slopes that are dissected by waterways in places. It is below less sloping Fayette soils and above steeper Fayette and Sogn soils. This soil has a profile similar to the one described as representative for the series, but the dark grayish-brown plow layer is a mixture of material from the brown to dark yellowish-brown subsoil and the original surface layer. The plow layer is much lighter in color when dry. Part of the surface and subsurface layers has been removed by erosion. The plow layer of this Fayette soil is lower in fertility and content of organic matter than that of uneroded Fayette soils. In places this soil puddles during intense rains, resulting in increased runoff and retarded plant growth. This soil becomes cloddy if it is worked when wet.

Included with this soil in mapping are small areas of soils that have a darker, thicker surface layer and a higher content of organic matter than this Fayette soil.

This soil is cultivated or was formerly cultivated. It is better suited to hay and pasture than to row crops. It can be used for row crops when the pasture needs renovating. Capability unit IVe-1; woodland suitability group 4.

Fayette silt loam, 14 to 18 percent slopes, severely eroded (163E3).—This soil has short, convex slopes that have been dissected by gullies and waterways. It is below less sloping Fayette soils and above steeper Fayette and Sogn soils. The present surface layer is generally brown silt loam, but in places it is silty clay loam. This soil is lower in content of organic matter and fertility than less eroded Fayette soils. During intense rain this soil puddles readily, resulting in increased runoff and retarded plant growth. This soil is cloddy if it is cultivated.

This soil is better suited to hay and permanent pasture than to row crops. Capability unit VIe-1; woodland suitability group 4.

Fayette silt loam, 18 to 30 percent slopes (163F).—This soil is on side slopes that are commonly along Cedar and Wapsipinicon Rivers and Buffalo Creek. It is below less sloping Fayette soils. In timbered areas this soil has a thin leaf litter covering the very dark gray surface layer.

Included with this soil in mapping are areas of soils that are steeper than this soil, and outcrops of limestone are in some places.

Most of this Fayette soil is in timber or is used for pasture. This soil is better suited to pasture, timber, and wildlife habitat than to most other uses. In many areas it is difficult to renovate pastures safely with farm machinery because of the steep slopes. Capability unit VIe-1; woodland suitability group 5.

Fayette silt loam, 18 to 30 percent slopes, moderately eroded (163F2).—This soil is on side slopes that are commonly along Cedar and Wapsipinicon Rivers and Buffalo Creek. It is below less sloping Fayette soils. This soil has a profile similar to the one described as representative for the series, but part of the surface and subsurface layers has been removed by erosion. The dark grayish-brown plow layer is a mixture of the brown material in the subsoil and the material originally in the surface layer. This plow layer is lower in fertility and content of organic matter than uneroded Fayette soils. In places this soil puddles during intense rains, resulting in retarded plant growth.

Included with this soil in mapping are some severely eroded soils that are lower in content of organic matter and fertility than this Fayette soil. Also included are soils that are steeper than this soil, and outcrops of limestone are in a few places.

This soil is cultivated or was formerly cultivated, but it is better suited to timber, pasture, and wildlife habitat. In many areas it is difficult to renovate pastures because of steep slopes. Capability unit VIe-1; woodland suitability group 5.

Fayette silt loam, benches, 2 to 5 percent slopes (T163B).—This Fayette soil is on stream benches along

Cedar and Wapsipinicon Rivers and their tributaries. It is commonly associated with Atterberry, Tama, and Tell soils. In places sand is at a depth of 4 feet.

Included with this soil in mapping are a few areas of nearly level soils that are not subject to erosion.

This soil is well suited to row crops, but it is subject to erosion if it is cultivated. Capability unit IIe-1; woodland suitability group 4.

Flagler Series

The Flagler series consists of somewhat excessively drained soils on stream benches and uplands. These soils are nearly level to moderately sloping. They formed in about 24 to 30 inches of stratified moderately coarse textured alluvium and loamy sand and sand containing some gravel. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish brown sandy loam about 12 inches thick. The subsoil is dark-brown and dark yellowish-brown sandy loam in the upper part and dark-brown gravelly loamy sand in the lower part. The substratum, at a depth of 40 inches, is yellowish-brown sand that contains some gravel.

Flagler soils have low to very low available water capacity. Permeability is moderately rapid in the upper part of the profile and very rapid in the coarse-textured substratum. These soils are low in available nitrogen and very low in available phosphorus and potassium. In most places they are acid and need lime where they have not been limed within the last 5 years.

These soils are suited to row crops. The major concerns of management are droughtiness and soil erosion.

Representative profile of Flagler sandy loam, 2 to 5 percent slopes, in a south-facing, convex area in a permanent pasture, 350 feet east and 690 feet south of the northwest corner of NE¼NW¼ sec. 15, T. 86 N., R. 7 W.:

A1—0 to 7 inches, very dark brown (10YR 2/2) sandy loam; weak, fine, granular structure; very friable; medium acid; gradual boundary.

A3—7 to 12 inches, very dark grayish-brown (10YR 3/2) sandy loam; weak, coarse, subangular blocky structure breaking to weak, fine, grannular structure; friable; strongly acid; gradual boundary.

B1—12 to 19 inches, dark-brown (10YR 3/3) sandy loam; weak, coarse, subangular blocky structure breaking to weak, fine, granular structure; very friable; strongly acid; gradual boundary.

B22t—19 to 25 inches, dark yellowish-brown (10YR 3/4) coarse sandy loam; very weak, coarse, subangular blocky structure; very friable; some clay bridging between sand grains; strongly acid; clear boundary.

IIB3—25 to 40 inches, dark-brown (7.5YR 4/4) coarse loamy sand that contains about 10 percent gravel; very weak, coarse, subangular blocky structure; very friable; some clay coatings on sand grains; medium acid; gradual boundary.

IIC—40 to 60 inches, yellowish-brown (10YR 5/6) sand that contains some gravel; single grain; loose; medium acid.

The solum typically ranges from 30 to 40 inches in thickness. Depth to loamy sand, gravelly sand, or sand ranges from 24 to 30 inches. The A1 or Ap horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon ranges from about 12 to 20 inches in thickness. The B2 horizon has a hue of 10YR or 7.5YR, a value of 3 to 5, and a chroma of 3 to 6. The B2 horizon ranges from 10 to 18 percent in content of clay, and it typically is 60 to 70 percent sand. The IIC horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 4 to 8. The IIC horizon typically is gravelly sand, gravelly loamy sand, or coarse sand. The content of gravel, by volume, is about 5 to 15 percent. Reaction is medium acid to strongly acid in the most acid part of the solum.

Flagler soils are associated with Burkhardt, Dickinson, Lawler, Saude, and Waukee soils. They have more sand and are coarser textured in the upper horizons than Lawler and Waukee soils. They have a browner B horizon and are better drained than Lawler soils. Flagler soils are deeper over sand and gravel than Burkhardt soils, and they contain more coarse sand and gravel in the C horizon than Dickinson soils.

Flagler sandy loam, 0 to 2 percent slopes (284A).—This soil is on stream benches on uplands. It is associated with Burkhardt, Lawler, Saude, and Waukee soils on stream benches and with Burkhardt, Dickinson, and Kenyon soils on uplands. The surface layer is very dark brown sandy loam 14 to 17 inches thick. A few pebbles are in the surface layer and in the upper part of the subsoil. Depth to coarse sand and gravel is about 24 to 30 inches.

Included with this soil in mapping are a few small areas of soils where the surface layer is lighter colored than that of this soil and fertility and content of organic matter are lower.

This soil is suited to row crops. However, it is droughty, and in most years crop production is decreased because of lack of moisture. It is subject to soil blowing if it is cultivated. Capability unit IIIs-1; woodland suitability group 2.

Flagler sandy loam, 2 to 5 percent slopes (284B).—This soil is on stream benches and on uplands. It is commonly associated with Burkhardt and Waukee soils on stream benches and with Burkhardt and Kenyon soils on uplands. The profile of this soil is the one described as representative for the series. Coarse sand and gravel is at a depth of about 24 inches.

Included with this soil in mapping are small areas of soils where the surface layer is lighter colored than that of this soil and fertility and content of organic matter are lower.

This soil is suited to row crops, but it is droughty and productivity is low unless rain is timely and is normal or above normal. It is subject to soil blowing and water erosion if it is cultivated. Capability unit IIIe-3; woodland suitability group 2.

Flagler sandy loam, 5 to 9 percent slopes (284C).—This soil is on stream benches and on sides of moundlike ridges on uplands. It is associated with Burkhardt and Waukee soils on stream benches and with Kenyon soils on uplands. The surface layer is about 10 to 12 inches of very dark brown sandy loam.

Included with this soil in mapping are a few areas of soils where the surface layer is lighter colored than that of this soil, and fertility and content of organic matter are lower.

This soil is suited to row crops, but production generally is low and depends on the amount and timeliness of rain. It is subject to both soil blowing and water erosion if it is cultivated. Capability unit IIIe-3; woodland suitability group 2.

Flagler sandy loam, 5 to 9 percent slopes, moderately eroded (284C2).—This soil is on stream benches and on moundlike ridges and side slopes on uplands. It is commonly associated with Burkhardt soils or moderately

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sloping Saude soils on stream benches and with Burkhardt and Kenyon soils on uplands. The plow layer is very dark brown to dark brown sandy loam, and erosion has removed part of the surface layer. Coarse-textured sand and gravel are at a shallower depth and content of organic matter is lower than in uneroded Flagler soils.

Included with this soil in mapping are some areas of severely eroded soils where the surface layer is thinner and lighter colored than that of this soil and fertility and content of organic matter are lower.

This soil is suited to row crops, but it is droughty and production depends on the amount and timeliness of rain. It is subject to further erosion if it is cultivated. Capability unit IIIe-3; woodland suitability group 2.

Floyd Series

The Floyd series consists of somewhat poorly drained soils that formed in 30 to 45 inches of loamy material and stratified loamy and sandy sediment underlain by glacial till. These soils are gently sloping and are in concave areas at the head of drainageways or on side slopes adjacent to drainageways, on uplands. Native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark gray loam about 21 inches thick. The subsoil is about 30 inches thick. The upper 9 inches is dark grayish-brown, friable loam and has grayish-brown and yellowish-brown mottles. The lower 21 inches is yellowish-brown sandy loam and heavy loam and has grayish-brown mottles. The substratum is yellowish-brown, mottled, firm loam.

Floyd soils have moderate permeability and high available water capacity. They are low to medium in available nitrogen and very low to low in available phosphorus and potassium. In most places these soils are slightly acid to neutral.

These soils are commonly used for row crops where they are drained. They are in pasture where they are not drained. They are wet, partly because of hillside seepage from soils upslope.

Representative profile of Floyd loam, 1 to 4 percent slopes, in a cultivated field, 500 feet east and 520 feet south of the northwest corner of NW¼NW¼ sec. 30, T. 86 N., R. 5 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam, very dark brown (10YR 2/2) when kneaded; weak cloddy, breaking to weak, fine, granular structure; friable; slightly acid; abrupt, smooth boundary.

A12—7 to 12 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; neutral; gradual boundary.

A3—12 to 21 inches, very dark gray (10YR 3/1) heavy loam; weak, fine, granular structure and weak, fine, subangular blocky structure; friable; neutral; gradual boundary.

B1—21 to 30 inches, dark grayish-brown (2.5Y 4/2) heavy loam; few, fine, faint, grayish-brown (2.5Y 5/2) mottles and few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; neutral; clear boundary.

IIB21—30 to 40 inches, yellowish-brown (10YR 5/6) sandy loam; weak, fine to medium, subangular blocky structure; friable; grayish-brown (2.5Y 5/2) ped coatings; band of pebbles at a depth of 30 inches; neutral; clear boundary.

IIB22—40 to 51 inches, yellowish-brown (10YR 5/6) heavy loam; many, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky structure; friable; lenses of sandy clay loam in upper part of horizon; neutral; gradual boundary.

IIC—51 to 63 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; firm; neutral.

The solum ranges from about 40 to 60 inches in thickness. Depth to the loamy overburden that is underlain by loam glacial till ranges from 30 to 45 inches. The A1 horizon typically is black (10YR 2/1) but ranges from black (N 2/0) to very dark gray (10YR 3/1). The A3 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (2.5Y 3/2). The A horizon typically is loam but ranges to gritty silt loam, light clay loam, and gritty light silty clay loam. The B horizon has a hue of 2.5Y or 10YR, a value of 4 or 5, and a chroma of 2 to 6. The B horizon ranges from loam to gritty silty clay loam, light clay loam, and thin layers of sandy loam that have a weighted clay content of more than 18 percent. Depth to carbonates ranges from 50 to 80 inches. Reaction of the solum ranges from neutral to slightly acid.

Floyd soils are closely associated with Clyde, Oran, Readlyn, and Schley soils. They have a thicker, darker colored A horizon than Oran and Schley soils. They are more stratified, are deeper over glacial till, and are less acid than Readlyn soils. Their B horizon is not so gray as that in poorly drained Clyde soils.

Floyd loam, 1 to 4 percent slopes (198B).—This soil is in concave areas at heads of drainageways or on side slopes along drainageways. It is commonly downslope from Bassett, Kenyon, Oran, and Readlyn soils and upslope from Clyde soils. In uncultivated areas stones or boulders are common on the surface.

Included with this soil in mapping are a few areas of soils that have 6 to 20 inches of light-colored, recent overwash and areas of soils that have coarser textured material in the substratum than this soil.

This soil is well suited to intensive row crops of corn and soybeans if it is drained. Wetness is the major limitation, but in a few areas erosion is a hazard. Because wetness is partly a result of hillside seepage, a drainage system that intercepts laterally moving water is effective. Capability unit IIw-1; woodland suitability group 7.

Franklin Series

The Franklin series consists of somewhat poorly drained soils that formed in 24 to 40 inches of loess and in loam glacial till. These soils are nearly level on upland divides and gently sloping in concave areas at the head of drainageways. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is black silt loam about 6 inches thick. The subsurface layer, about 7 inches thick, is dark grayish-brown silt loam. The upper part of the subsoil is dark grayish-brown and grayish-brown silty clay loam that has yellowish-brown and light olive-brown mottles. At a depth of about 28 inches, the subsoil is yellowish-brown loam and has grayish mottles. The substratum, at a depth of 64 inches, is yellowish-brown, mottled, calcareous loam glacial till.

Franklin soils have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. They have high available water capacity. They are low in available nitrogen and very low in available phosphorus and potasium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops, but at times they have a seasonal high water table and some areas need tile drainage.

Representative profile of Franklin silt loam, 0 to 2 percent slopes, in a cultivated field, 240 feet west and 130 feet south of the northeast corner of SE¼NE¼ sec. 14, T. 84 N., R. 7 W.:

Ap—0 to 6 inches, black (10YR 2/1) silt loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—6 to 13 inches, dark grayish-brown (10YR 4/2) silt loam; weak, thin, platy structure; friable; few, discontinuous, very dark grayish-brown (10YR 3/2) coatings; few, fine, faint, dark yellowish-brown (10YR 4/4) oxide concretions; strongly acid; clear boundary.

B1—13 to 18 inches, dark grayish-brown (2.5Y 4/2) light silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, fine, subangular blocky structure; friable; few, discontinuous, very dark grayish-brown (2.5Y 3/2) coatings; few, fine, strong-brown (7.5YR 5/6) oxide concretions; strongly acid; gradual boundary.

B21t—18 to 28 inches, dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) medium silty clay loam; common, fine, faint, light olive-brown (2.5Y 5/4) mottles; moderate, fine and medium, subangular blocky structure; friable; few, thin, discontinuous clay films; medium acid; abrupt boundary.

IIB22t—28 to 37 inches, yellowish-brown (10YR 5/6) heavy loam; common, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; weak, coarse, prismatic structure breaking to weak, thin, subangular blocky structure; firm; thin discontinuous clay films; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings; band of pebbles at depth of 28 inches; medium acid; gradual boundary.

IIB31—37 to 48 inches, yellowish-brown (10YR 5/6) heavy loam; few, fine, distinct, grayish-brown (10YR 5/2) and light brownish-gray (2.5Y 6/2) mottles; weak, coarse, prismatic structure; firm; few, fine, black oxide concretions; medium acid; gradual boundary.

IIB32—48 to 64 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, coarse, prismatic structure; firm; neutral; gradual boundary.

IIC—64 to 74 inches, yellowish-brown (10YR 5/6) loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; firm; calcareous.

The solum typically is more than 48 inches thick but ranges from 40 inches to about 70 inches in thickness. The solum formed partly in loess and partly in glacial till. The loess is typically 24 to 40 inches thick but ranges from 20 to 42 inches in thickness. The Ap horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick. The A2 horizon typically has a hue of 10YR or 2.5Y, a value of 4 or 5, and a chroma of 2. It is about 4 to 8 inches thick. The upper part of the B horizon ranges from dark grayish brown (10YR 4/2 or 2.5Y 4/2) to grayish brown (10YR 5/2) or olive brown (2.5Y 4/4) but has higher chroma mottles. The upper part of the B horizon ranges from light to medium silty clay loam that is 28 to 34 percent clay. In most places a stone line or a thin lens of sandy material is at a depth of 24 to 40 inches and separates the silty upper part of the B horizon from the loamy lower part. The IIB horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 4 to 8, but it has lower chroma mottles. The lower part of the B horizon typically is loam, but in places it is light clay loam or sandy clay loam. Reaction of the B horizon is medium acid to strongly acid in the most acid part.

Franklin soils formed in material similar to that in which Dinsdale, Klinger, and Maxfield soils formed, and they are in the same drainage class as Atterberry and Oran soils. Franklin soils have a thinner A horizon than Dinsdale, Klinger, and Maxfield soils. They are better drained than Maxfield soils but more poorly drained than Dinsdale soils. Franklin soils are shallower to glacial till than Atterberry soils, and they contain less sand and more silt in the upper part of the solum than Oran soils.

Franklin silt loam, 0 to 2 percent slopes (761A).—This soil is on upland divides and at the head of drainageways. It is commonly associated with Dinsdale, Klinger, and Maxfield soils. The profile of this soil is the one described as representative of the series.

Included with this soil in mapping are areas of soils where the surface layer has a slightly higher content of sand than that of this Franklin soil. Also included are a few small areas of poorly drained soils that are indicated on the soil map by a special symbol. These soils are wetter than surrounding soils and need drainage.

This soil is well suited to intensive row crops if it is properly managed. It has a moderately high water table at times during wet seasons and benefits from tile drainage. Capability unit I–2; woodland suitability group 7.

Franklin silt loam, 2 to 5 percent slopes (761B).—This soil is at the head of upland drainageways and at the base of side slopes. It is associated with Dinsdale and Klinger soils. This soil is dominantly in downslope positions. The plow layer is black or very dark gray silt loam underlain by a lighter colored subsurface layer.

Included with this soil in mapping are areas of soils where the surface layer has a slightly higher content of sand than the surface layer of this soil.

This soil can be used intensively for row crops, but erosion control practices are needed in places. Tile drainage is beneficial in some years. Because wetness is caused in part by seepage, drainage that intercepts laterally moving water is most likely to be effective. Capability unit IIe–3; woodland suitability group 7.

Garwin Series

The Garwin series consists of poorly drained soils that formed in loess more than 40 inches thick. These soils are in depressions at the head of upland drainageways and, in a few places, on loess-covered stream benches. Native vegetation was prairie grasses and sedges.

In a representative profile the surface layer is black to very dark gray silty clay loam about 22 inches thick. The subsoil, to a depth of 46 inches, is dark grayish-brown to olive-gray, mottled silty clay loam that grades to heavy silt loam as depth increases. The substratum is olive-gray heavy silt loam that has strong-brown mottles.

Garwin soils have moderately slow permeability and high available water capacity. They are medium in available nitrogen and very low in available phosphorus and potassium. They are slightly acid to neutral and generally do not need lime for optimum growth of crops.

These soils are well suited to corn and soybeans.

Representative profile of Garwin silty clay loam, in a cultivated field, 300 feet east and 160 feet south of the northwest corner of SW¼NW¼ sec. 12, T. 82 N., R. 5 W.:

Ap—0 to 9 inches, black (N 2/0) light silty clay loam; cloddy, breaking to weak, fine, granular structure; firm; neutral; clear boundary.

A12—9 to 16 inches, black (10YR 2/1) silty clay loam; weak, very fine, granular and subangular blocky structure; friable; slightly acid; gradual boundary.

A3—16 to 22 inches, very dark gray (10YR 3/1) silty clay loam, slightly higher chroma when kneaded; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; weak, very fine, subangular blocky structure; firm; black (10YR 2/1) coatings on ped faces in upper part of horizon; few dark reddish-brown (5YR 2/2) and strong-brown (7.5YR 5/6) oxide concretions; slightly acid; gradual boundary.

B21—22 to 28 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, fine, subangular blocky structure; firm; few, thin, discontinuous clay films; few, discontinuous, dark-gray (5Y 4/1) coatings; few, fine, dark reddish-brown (5YR 2/2) oxide concretions; slightly acid; gradual boundary.

B22g—28 to 36 inches, olive-gray (5Y 5/2) silty clay loam; common, fine, prominent, strong-brown (7.5YR 5/6) mottles; weak, fine, prismatic structure breaking to weak, fine, subangular blocky structure; firm; common dark reddish-brown (5YR 2/2) oxide concretions; neutral; gradual boundary.

B3g—36 to 46 inches, olive-gray (5Y 5/2) heavy silt loam; common, medium, prominent, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure; friable; neutral; gradual boundary.

Cg—46 to 60 inches, olive-gray (5Y 5/2) heavy silt loam; common, medium, prominent, strong-brown (7.5YR 5/8) mottles; massive; friable; neutral.

The solum ranges from 36 to 50 inches in thickness. The A1 or Ap horizon ranges from black (N 2/0) to very dark gray (10YR 3/1). The A horizon ranges from 14 to 23 inches in thickness and from silty clay loam to heavy silt loam. The B2 horizon has hues of 5Y and 2.5Y, a value of 3 to 5, and a chroma of 1 or 2. The B1 or B2 horizon is 30 to 36 percent clay. Depth to carbonates is from 48 to 70 inches or more. Reaction is slightly acid to neutral in the most acid part of the solum.

Garwin soils formed in material similar to that in which Muscatine and Tama soils formed, and they are in the same drainage class as Maxfield soils. They formed in more than 40 inches of loess, but Maxfield soils formed in about 24 to 40 inches of loess and glacial till. Garwin soils have a grayer B horizon and are more poorly drained than Muscatine and Tama soils.

Garwin silty clay loam (0 to 2 percent slopes) (118).—This soil is commonly in slightly concave areas at the head of upland drainageways. It also occurs on a few loess-covered stream benches. It is commonly adjacent to other upland soils, such as Atterberry, Muscatine, and Tama. Colo and Ely soils commonly are in drainageways adjoining Garwin soils.

This soil is well suited to intensive use for corn and soybeans if tile drainage is used. Tilth is generally good, but this soil puddles if it is worked when wet. Capability unit IIw-1; woodland suitability group 9.

Hayfield Series

The Hayfield series consists of somewhat poorly drained soils that formed in 24 to 40 inches of loamy alluvial deposits in areas of loamy sand and some gravel. These soils are nearly level on stream benches and in places are in upland drainageways that lack well-defined outlets. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is black loam about 7 inches thick. The subsurface layer is dark grayish-brown, friable silt loam that has some mottles. The subsoil is 37 inches thick. The upper 6 inches is dark-grayish brown and brown, friable, mottled silt loam. The next 20 inches is light brownish-gray, yellowish-brown, and light olive-gray, mottled loam. The lower 11 inches is light brownish-gray and yellowish-brown, very friable loamy sand. The substratum, at a depth of 47 inches, is yellowish-brown, mottled loamy sand that contains gravel.

Hayfield soils have low to moderate available water capacity, depending on depth to sand and gravel. These soils have moderate permeability above the sand, but permeability is very rapid in the sand and gravel. They are low in available nitrogen and very low in available phosphorus and potassium. They are generally acid where they have not been limed within the last 5 years.

These soils are well suited to row crops, but in some seasons field operations are delayed because of wetness. Later in the growing season they are droughty, especially the moderately deep soils.

Representative profile of Hayfield loam, deep, in a cultivated field, 150 feet east and 440 feet north of the southwest corner of SW¼NW¼ sec. 36, T. 85 N., R. 7 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—7 to 10 inches, dark grayish-brown (10YR 4/2) silt loam; common, fine, distinct, dark yellowish-brown (10YR 4/4) mottles and few, fine, faint, grayish-brown (10YR 5/2) mottles; weak, medium, platy structure; friable; few, fine, black oxide concretions; neutral; clear boundary.

B1—10 to 16 inches, dark grayish-brown (10YR 4/2) and brown (10YR 4/3) silt loam; common, fine, faint, dark yellowish-brown (10YR 4/4) and grayish-brown (2.5Y 5/2) mottles; weak, fine, subangular blocky structure; friable; few strong-brown and black oxide concretions; strongly acid; gradual boundary.

B21—16 to 26 inches, light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/4) loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; very weak, fine to medium, subangular blocky structure; few, fine, dark-brown (7.5YR 3/2) oxide concretions; medium acid; gradual boundary.

B22t—26 to 36 inches, light olive-gray (5Y 6/2) and yellowish-brown (10YR 5/4) loam; weak, medium, subangular blocky structure; few patchy clay films; light-gray (5Y 6/1) coatings on some peds; common dark-brown (7.5YR 4/4) oxide concretions; medium acid; gradual boundary.

IIB3t—36 to 47 inches, light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/6) coarse loamy sand; very weak, coarse, subangular blocky structure; very friable; clay bridging between sand grains; common dark-brown (7.5YR 4/4) oxide concretions; strongly acid; clear boundary.

IIC—47 to 60 inches, yellowish-brown (10YR 5/6) loamy sand and fine gravel (30 percent gravel); many, medium, distinct, light brownish-gray (2.5Y 6/2) and strong-brown (7.5Y 5/6) mottles; single grained; loose; strongly acid.

The solum ranges from about 24 to 50 inches in thickness, and depth to contrasting texture ranges from about 24 to 40 inches. The A1 or Ap horizon ranges from 6 to 19 inches in thickness. It has a hue of 10YR, a value of 2 or 3, and a chroma of 1 or 2. The A2 horizon has a value of 4 or 5 and chroma of 2 or 3. It is 3 to 7 inches thick. The B horizon has a hue of 10YR to 2.5Y, a value of 3 to 6, and a chroma of 2 to 4. Where chroma is 3 or 4, there are lower chroma mottles. The B horizon typically is loam, silt loam that is high in content of sand, light clay loam, or sandy clay, but in some places the lower part of the horizon is sandy loam or loamy sand. The C horizon has a value of 4 to 6, a chroma of 2 to 6, and a hue of 10YR or 2.5Y. It is dominantly loamy sand, coarse sand, or sand that contains some gravel. Re-

action ranges from medium acid to very strongly acid in the most acid part of the solum.

Hayfield soils formed in material similar to that in which Lawler, Marshan, Sattre, Saude, Wapsie, and Waukee soils formed. They have a grayer B horizon and are more poorly drained than Sattre, Saude, Wapsie, or Waukee soils. They have a thinner A horizon than Lawler and Marshan soils, and they are better drained than Marshan soils.

Hayfield loam, deep (0 to 2 percent slopes) (726).—This soil is on stream benches and in outwash areas on uplands. It is commonly associated with Lawler, Marshan, and Wapsie soils. The profile of this soil is the one described as representative for the series. Depth to sand and gravel is 30 to 40 inches.

Included with this soil in mapping are a few areas of soils that have 6 to 20 inches of light-colored overwash and areas of soils that have coarse-textured material at a depth as shallow as 30 inches or as deep as 45 inches. Also included are small areas of soils where the surface layer and subsoil contain more silt than this Hayfield soil.

This soil can be used intensively for row crops if it is properly managed. It is somewhat poorly drained and benefits from tile drainage during wet years. Tile placement is difficult in some places because of loose, water-bearing sand and gravel. Capability unit I–2; woodland suitability group 7.

Hayfield loam, moderately deep (0 to 2 percent slopes) (725).—This soil is on stream benches or in outwash areas on uplands. It is commonly associated with Marshan, Sattre, and Wapsie soils and deep Hayfield soils. This soil has a profile similar to the one described as representative for the series, but depth to sand and gravel ranges from 24 to 30 inches, and in a few areas it is as shallow as 20 inches.

Included with this soil in mapping are areas of soils where the surface layer is sandy loam and sand and gravel in the subsoil and in the substratum are at a shallower depth than in this Hayfield soil. These areas are commonly underlain by fine-textured material below a depth of 60 inches, and they tend to be wetter than is typical. Also included are small areas of soils where the surface layer and the subsoil contain more silt than those in this soil.

This soil is moderately well suited to row crops if it is properly managed. Because the sandy substratum is close to the surface, the water table fluctuates rapidly. Therefore, this soil can be both wet and droughty during the growing season, depending on the amount and timeliness of rain. During some years when the water table is seasonally high, this soil benefits from tile drainage. Tile placement is difficult in places because of loose water-bearing sand and gravel. Capability unit IIs–2; woodland suitability group 7.

Judson Series

The Judson series consists of silty soils that formed in local alluvium washed from higher loess-covered hillsides. These soils are well drained to moderately well drained. They are gently sloping on foot slopes and fans where waterways empty onto bottom lands. Native vegetation was prairie grasses.

In a representative profile the surface layer is black, very dark brown, and very dark grayish-brown light silty clay loam about 30 inches thick. The upper part of the subsoil is dark-brown to yellowish-brown silty clay loam that extends to a depth of 54 inches. The lower part is yellowish-brown silt loam that has grayish-brown mottles.

Judson soils have moderate permeability and high available water capacity. These soils are low to medium in available nitrogen and low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops. They receive runoff from soils upslope during periods of intense rain, but the areas do not pond. Diversion terraces are effective in intercepting runoff from higher lying soils.

Representative profile of Judson silty clay loam, 2 to 5 percent slopes, in a cultivated field, 132 feet south and 343 feet east of the northwest corner of NW¼SW¼ sec. 30, T. 84 N., R. 8 W.:

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; weak cloddy, breaking to weak, fine, subangular blocky structure; friable; slightly acid; abrupt boundary.

A12—7 to 18 inches, black (10YR 2/1) light silty clay loam; weak, fine, granular structure; friable; slightly acid; gradual boundary.

A13—18 to 24 inches, very dark brown (10YR 2/2) light silty clay loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

A3—24 to 30 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; moderate, fine, subangular blocky structure; friable; few black (10YR 2/1) coatings on ped exteriors; slightly acid; gradual boundary.

B21—30 to 42 inches, dark-brown (10YR 3/3) silty clay loam; very dark grayish-brown (10YR 3/2) ped exteriors; moderate, medium, subangular blocky structure; friable; very few, thin, discontinuous clay films; medium acid; gradual boundary.

B22—42 to 54 inches, yellowish-brown (10YR 5/4) light silty clay loam; brown (10YR 4/3) ped exteriors; moderate, medium, subangular blocky structure; friable; medium acid; gradual boundary.

B3—54 to 65 inches, yellowish-brown (10YR 5/6) heavy silt loam; common, fine to medium, distinct, grayish-brown (10YR 5/2) mottles; weak, coarse, subangular blocky structure; friable; few pores filled with dark-brown to brown (7.5YR 4/4) clay; many dark reddish-brown (5YR 2/2) oxide concretions; medium acid.

The solum ranges from 48 to 60 inches or more in thickness. The A horizon ranges from 24 to 36 inches in thickness. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and ranges to very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3) in the lower part. It is silt loam or silty clay loam, and the clay content ranges from 24 to 30 percent. The B horizon has a value of 3 to 5 and a chroma of 3 to 6 but in places the upper part of the B horizon has darker coated ped exteriors. The B2 horizon ranges from light to medium silty clay loam in the finest textured part. A few grayish-brown mottles are below a depth of 30 inches in places. Reaction is medium acid in the most acid part of the solum.

Judson soils formed in material similar to that in which Ely and Kennebec soils formed. They have a browner B horizon and are better drained than Ely soils. The dark-colored surface layer of Judson soils is not so thick as that of Kennebec soils.

Judson silty clay ~~loam, 2 to 5 percent slopes~~ (8B).—This soil is on alluvial fans or foot slopes. It is at the base of loess-covered uplands and downslope from Downs and Tama soils.

Included with this soil in mapping are small areas of moderately sloping soils and a few areas of soils that

have a loam surface layer that is dark colored to a depth of more than 36 inches. Also included are some areas that have sandy overwash, which are indicated on the soil map by a sand symbol, and some areas that have 6 to 20 inches of light-colored silt loam overwash. Small areas of somewhat poorly drained soils that benefit from tile drainage during some wet years are also included.

This soil is well suited to row crops, but it is subject to slight erosion if it is cultivated. Many areas of this soil are small, and they are generally cultivated with adjoining soils. Capability unit IIe-4; woodland suitability group 4.

Kennebec Series

The Kennebec series consists of somewhat poorly drained to moderately well drained soils that formed in silty alluvium under prairie grasses. These soils are nearly level and are on flood plains, on alluvial fans, and in narrow upland waterways.

In a representative profile the surface layer is black and very dark brown silt loam and light silty loam about 43 inches thick. The substratum is very dark brown and very dark gray, mottled, friable and very friable sandy loam and heavy loam.

Kennebec soils have moderate permeability and high available water capacity. These soils are medium in available nitrogen and phosphorus and very low in available potassium. They are slightly acid to neutral and generally do not need lime.

These soils are well suited to corn and soybeans, but in some years crops are damaged by floods. The series have a seasonal high water table.

Representative profile of Kennebec silt loam, in a level cultivated field, 4 feet north and 7 feet east of the southwest corner of SW¼SW¼ sec. 30, T. 82 N., R. 5 W.:

- Ap—0 to 5 inches, black (10YR 2/1) silt loam; weak, fine, granular structure; friable; neutral; clear, smooth boundary.
- A12—5 to 35 inches, very dark brown (10YR 2/2) light silty clay loam; black (10YR 2/1) ped exteriors; weak, fine, granular structure and weak, fine, subangular blocky structure; friable; neutral; gradual boundary.
- A13—35 to 43 inches, very dark brown (10YR 2/2) heavy silt loam; weak, fine, subangular blocky structure; friable; neutral; clear boundary.
- IIC1—43 to 47 inches, very dark brown (10YR 2/2) sandy loam; few, fine, faint, dark-brown (7.5YR 3/2) mottles; weakly stratified, very friable; neutral; gradual boundary.
- IIC2—47 to 58 inches, very dark brown (10YR 2/2) and very dark gray (10YR 3/1) sandy loam; common, fine, distinct mottles and very weak, fine, dark-brown (7.5YR 3/2) mottles; subangular blocky structure; friable; neutral; gradual boundary.
- IIC3—58 to 72 inches, very dark brown (10YR 2/2) and very dark gray (10YR 3/1) heavy loam; common, fine, distinct, dark-brown (7.5YR 3/2) mottles; very weak, fine, subangular blocky structure; friable; neutral.

The A horizon is more than 36 inches thick. It is black (10YR 2/1) and very dark brown (10YR 2/2) and in some profiles grades to very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. The hue commonly is 10YR in the A and C horizons, but in places it is 2.5Y in the C horizon. The A and C horizons typically are 24 to 30 percent clay, but below a depth of 40 inches the amount is variable. Kennebec soils have more sand below a depth of 40 inches than is typical for the series in other counties.

Kennebec soils formed in material similar to that in which Colo, Lawson, Nodaway, and Spillville soils formed. They contain more silt and less sand than Spillville soils, are dark colored to a greater depth than Lawson soils, and are not so poorly drained as Colo soils; also, they contain less clay throughout than those soils. They typically are darker colored than Nodaway soils and are not stratified as are Nodaway soils.

Kennebec silt loam (0 to 2 percent slopes) (212).—This soil is on bottom lands, at the mouth of drainageways, and in narrow upland waterways. It commonly is adjacent to Colo, Lawson, Nodaway, or Spillville soils.

Included with this soil in mapping are small areas of soils that have 6 to 20 inches of light-colored, recent overwash. Small wet spots that hinder farm operations are also included. These areas are indicated on the soil map by a special symbol.

This soil can be used intensively for corn and soybeans if it is well managed. It is subject to occasional floods during periods of heavy rain, and it has a seasonal high water table. Capability unit I-3; woodland suitability group 8.

Kenyon Series

The Kenyon series consists of moderately well drained soils that formed in loamy material and underlying firm glacial till. These soils are gently sloping to moderately sloping on uplands. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and dark-brown loam about 17 inches thick. The upper part of the subsoil is dark yellowish-brown, friable heavy loam. The part of the subsoil below a depth of 24 inches, which formed in glacial till, is yellowish-brown heavy loam. It has grayish mottles below a depth of 24 inches. The substratum, at a depth of 52 inches, is mottled yellowish-brown and grayish-brown, firm loam.

The rate at which water moves through the friable loamy material differs from the rate at which it moves through in the firm glacial till. Water moves more rapidly in the overburden and accumulates at the till contact. Wet, seepy areas are evident in some years.

Kenyon soils have high available water capacity. They have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. They are low to medium in available nitrogen and very low in available phosphorus and potassium. They are commonly acid and need lime where they have not been limed within the last 5 years.

These soils are well suited to row crops if properly managed. The concerns of providing adequate drainage and controlling erosion on these soils are difficult because they conflict to some extent. The long, uniform upland slopes are well suited to contour cultivation and terracing. These practices slow down movement of surface water and allow more water to soak into the soil. The extra water that enters the soil complicates drainage, especially in wet years. Consequently, a combination of tile drainage and terracing helps to overcome these limitations.

Representative profile of Kenyon loam, 2 to 5 percent slopes, in a south-facing convex area in a cultivated

field, 700 feet south and 180 feet west of the northeast corner of SE¼SE¼ sec. 14, T. 84 N., R. 7 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; cloddy, breaking to weak, medium, subangular blocky structure; friable; neutral; abrupt boundary.

A12—7 to 11 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; neutral; clear boundary.

A3—11 to 17 inches, dark-brown (10YR 3/3) loam; very dark grayish-brown (10YR 3/2) ped exteriors; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21—17 to 24 inches, dark yellowish-brown (10YR 4/4) heavy loam; brown (10YR 4/3) ped exteriors; weak, fine, subangular blocky structure; friable; band of pebbles at a depth of 24 inches; strongly acid; clear boundary.

IIB22—24 to 35 inches, yellowish-brown (10YR 5/6) heavy loam; few, fine, distinct, grayish-brown (2.5Y 5/2) mottles; moderate, medium, subangular blocky structure; firm; few small pebbles; few black (10YR 2/1) oxide concretions; strongly acid; gradual boundary.

IIB23—35 to 45 inches, yellowish-brown (10YR 5/6) heavy loam; grayish-brown (10YR 5/2) and brown (10YR 5/3) ped exteriors; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; firm; few small pebbles; few black (10YR 2/1) oxide concretions; strongly acid; gradual boundary.

IIB3—45 to 52 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky structure; firm; few small pebbles; common black (10YR 2/1) oxide concretions; medium acid; gradual boundary.

IIC—52 to 67 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) heavy loam; massive; firm; few small pebbles; few yellowish-red (5YR 5/8) oxide concretions; neutral.

The solum ranges from 45 to 60 inches in thickness. Loamy material is about 14 to 24 inches deep over firm loam glacial till. The Ap or A1 horizon is black (10YR 2/1) or very dark brown (10YR 2/2). In uneroded areas the A horizon ranges from about 10 to 20 inches in thickness, and thickness commonly decreases as slope increases. The A horizon typically is loam but ranges to silt loam that is high in content of sand. The B2 horizon has a hue of 10YR, a value dominantly of 3 to 5, and a chroma of 3 to 6. The IIB horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 8; mottles have a chroma of 2 or lower. The IIB horizon typically is heavy loam but ranges to light clay loam and sandy clay loam. The IIC horizon is similar to the IIB horizon in color and texture but grayish mottles are more common in the IIC horizon. Reaction ranges from medium acid to strongly acid in the most acid part of the solum.

Kenyon soils formed in material similar to that in which Aredale, Bassett, Oran, Readlyn, and Tripoli soils formed, and they are closely associated with Clyde, Floyd, and Schley soils. They have a thicker, darker colored A horizon than Bassett and Oran soils. They have a browner B horizon and are better drained than Clyde, Floyd, Readlyn, Schley, and Tripoli soils. Kenyon soils are shallower to firm till and to grayish mottles than Aredale soils.

Kenyon loam, 2 to 5 percent slopes (83B).—This soil is on convex ridges and side slopes on uplands. It is upslope from Clyde, Floyd, and Schley soils and more sloping Kenyon soils. The profile of this soil is the one described as representative for the series.

This soil is well suited to row crops if it is properly managed. It is subject to slight erosion if it is cultivated. Water tends to accumulate at a depth of about 18 inches because of the difference in permeability in the loamy overburden and that in the underlying glacial till. A temporary high water table results, especially early in spring. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tile drainage is needed in some places. Capability unit IIe-1; woodland suitability group 6.

Kenyon loam, 5 to 9 percent slopes (83C).—This soil is on short, convex side slopes on uplands. It is upslope from Clyde and Floyd soils and below gently sloping Kenyon soils. This soil has a profile similar to the one described as representative for the series, but the dark surface layer is not so thick.

Included with this soil in mapping are a few areas of sandy soils that are indicated on the soil map by a special symbol. These areas are droughty and are less productive than this Kenyon soil.

This soil is suited to row crops if it is properly managed. It is subject to moderate to severe erosion if it is cultivated. Contouring and terracing are practices that help to control erosion. In wet years, fieldwork is delayed slightly in places. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tile drainage is needed in some places. Capability unit IIIe-1; woodland suitability group 6.

Kenyon loam, 5 to 9 percent slopes, moderately eroded (83C2).—This soil is on short, convex side slopes on uplands. It is downslope from gently sloping Kenyon soils and upslope from Clyde and Floyd soils. This soil has a profile similar to the one described as representative of the series, but the plow layer is thinner, and part of the subsoil is mixed into it. Also, stones and pebbles on the surface interfere with farming operations in places. This soil is lower in content of organic matter and in fertility than slightly eroded Kenyon soils.

Included with this soil in mapping are areas of severely eroded soils that have little or no material in the surface layer and are lower in content of organic matter and in fertility than this Kenyon soil. Also included are areas of sandy soils that are indicated on the soil map by a special symbol. These sandy areas are droughty and less productive than this soil.

This soil is suited to row crows if it is properly managed. It is subject to severe erosion if it is cultivated. In wet years, fieldwork is delayed slightly. Because providing adequate erosion control and drainage is difficult, a combination of terracing and tile drainage is needed in some places. Capability unit IIIe-1; woodland suitability group 6.

Kenyon loam, 9 to 14 percent slopes, moderately eroded (83D2).—This soil is on convex side slopes close to drainageways. It occupies the entire slope in a few places. It is below less sloping Kenyon soils and above Clyde soils. This soil is similar to the one described as representative of the series, but its surface layer is very dark grayish-brown and friable, and part of the brown subsoil is mixed into it.

Included with this soil in mapping are small areas of severely eroded soils that have little or no material in the surface layer; they are lower in content of organic matter and in fertility than this Kenyon soil. These severely eroded areas are indicated on the soil map by a special spot symbol. Also included are small areas of soils where the surface layer is sandy loam. Small areas of sand and gravel are included and are in-

dicated on the soil map by a special symbol. These areas are droughty and less productive than this soil.

This soil is suited to row crops if it is well managed and if further erosion is controlled. Capability unit IIIe-2; woodland suitability group 6.

Klinger Series

The Klinger series consists of somewhat poorly drained soils on uplands. These soils formed in loess and glacial till. The loess ranges from about 24 to 40 inches in thickness. These soils are nearly level on broad ridges or flats and gently sloping on side slopes on uplands. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black to very dark grayish-brown silty clay loam about 19 inches thick. The upper part of the subsoil is dark grayish-brown, mottled silty clay loam. The lower part of the subsoil is grayish-brown, mottled heavy loam to a depth of 44 inches. The substratum is mottled yellowish-brown and gray heavy loam.

Klinger soils have moderate permeability in the upper part of the profile, which formed in loess, and moderately slow permeability in the lower part, which formed in glacial till. These soils have high available water capacity. They are low to medium in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to corn and soybeans. They have a seasonal high water table, and in some areas they benefit from tile drainage.

Representative profile of Klinger silty clay loam, 0 to 2 percent slopes, in a cultivated field, 50 feet west and 650 feet north of the southeast corner of SE¼NE¼ sec. 4, T. 83 N., R. 5 W.:

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; cloddy, breaking to weak, fine, granular structure; friable; medium acid; abrupt boundary.

A12—7 to 13 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; medium acid; gradual boundary.

A3—13 to 19 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; moderate, fine, subangular blocky structure; friable; common, fine, dark oxide concretions; medium acid; gradual boundary.

B21t—19 to 27 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam, very dark grayish-brown (2.5Y 3/2) ped exteriors; few, fine, distinct, yellowish-brown (10YR 5/4) mottles and many, fine, distinct, light olive-brown (2.5Y 5/4) mottles; weak to moderate, fine, subangular blocky structure; friable; thin discontinuous clay films; few, fine, dark oxide concretions; slightly acid; gradual boundary.

B22t—27 to 33 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam; common, fine, faint, yellowish-brown (10YR 5/4) and grayish-brown (2.5Y 5/2) mottles; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; friable; thin discontinuous clay films; slightly acid; gradual boundary.

IIB31t—33 to 44 inches, grayish-brown (2.5Y 5/2) heavy loam; common, medium, yellowish-brown (10YR 5/6) mottles; moderate, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; firm; thin discontinuous clay films; band of pebbles at a depth of 33 to 34 inches; slightly acid; clear boundary.

IIC—44 to 60 inches, mottled yellowish-brown (10YR 5/6) and gray (5Y 6/1) heavy loam; massive; firm; discontinuous yellowish-brown sand lens between depths of 39 and 43 inches; neutral.

The solum ranges from about 40 to 60 inches in thickness. The A horizon is typically black (10YR 2/1) or very dark brown (10YR 2/2). It grades in value to 3 and has a chroma of 1 or 2 in the lower part. It ranges from 18 to 22 inches in thickness. The B2t horizon is dominantly dark grayish brown (2.5Y 4/2). It has a value of 5 and a chroma of 3 or 4 in a minor part of the matrix. Clay content of the B2t horizon ranges from 28 to 35 percent. The IIBt horizon has a value of 4 or 5 and a chroma of 2, but the chroma of mottles is higher. The IIBt horizon is loam, light clay loam, or sandy clay loam. Reaction is medium acid to strongly acid in the most acid part of the solum.

Klinger soils are associated with Clyde, Dinsdale, Floyd, Franklin, Maxfield, Muscatine, and Readlyn soils. They have a thicker, darker colored A horizon than Franklin soils and have a grayer B horizon and are more poorly drained than Dinsdale soils. They have a higher sand content in the lower part of the B horizon than Muscatine soils. They contain less sand in the surface layer and in the upper part of the B horizon than Floyd and Readlyn soils. They are not so poorly drained as Clyde and Maxfield soils.

Klinger silty clay loam, 0 to 2 percent slopes (184A).—This soil is on uplands. It is commonly associated with Clyde, Dinsdale, Floyd, Franklin, Maxfield, Muscatine, and Readlyn soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas that are well drained and some small areas of soils that contain more sand in the surface layer than this Klinger soil. Also included are some areas of sandy soils and some areas of wet spots, which are indicated on the soil map by special symbols. The wet areas delay farming operations, especially after heavy rains.

This soil is well suited to intensive use for corn and soybeans. Runoff is slow. Although some areas can be farmed without tile drainage, tile is beneficial and makes earlier field operations possible. Capability unit I-2; woodland suitability group 7.

Klinger-Maxfield silty clay loams, 2 to 5 percent slopes (381B).—This complex consists of about 60 percent Klinger soils, about 30 percent Maxfield soils, and 10 percent included Colo silty clay loam. The soils in this unit are somewhat poorly drained and poorly drained. They are at the head of upland drainageways and at the base of side slopes. In most places Maxfield and Colo soils are in the lowest part of the drainageways and are bordered by a band of Klinger soils. The soils in this unit are associated with Clyde and Dinsdale soils.

These soils are suited to row crops if they are properly drained. They receive seepage and runoff from more sloping soils above them. Tile drains are effective if suitable outlets are obtained. Gullies form if drainageways that have a high concentration of water are not in grass. Most areas of these soils are farmed along with surrounding soils because individual areas generally are too small to be cropped separately. Capability unit IIw-1; woodland suitability group 9.

Lamont Series

The Lamont series consists of somewhat excessively drained soils that formed in eolian or wind-deposited material. These soils are gently sloping to moderately

sloping and are on uplands and stream benches. Native vegetation was trees.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam about 5 inches thick. The subsurface layer is dark grayish-brown, very friable sandy loam about 8 inches thick. The subsoil is brown and dark yellowish brown to strong brown. It is sandy loam in the upper 15 inches and loamy sand in the lower 6 inches. Below a depth of 34 inches is yellowish-brown sand containing dark-brown loamy sand and bands of clay and iron about ½ to 1 inch thick.

Lamont soils have moderately rapid permeability and low available water capacity. They are very low in available nitrogen and potassium and low in available phosphorus. They are acid where they have not been limed within the last 4 years. The more sloping areas of these soils are highly erodible.

These soils are suited to row crops, but a lack of moisture limits crop production in most years.

Representative profile of Lamont fine sandy loam, 2 to 5 percent slopes, in a north-facing, convex area in a permanent pasture, 50 feet west and 600 feet south of the northeast corner of NW¼NW¼ sec. 21, T. 83 N., R. 6 W.:

A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, grayish-brown (10YR 5/2) dry; weak, fine, granular structure; very friable; slightly acid; gradual boundary.

A2—5 to 13 inches, dark grayish-brown (10YR 4/2) sandy loam; weak, coarse, platy structure breaking to very weak, granular structure; very friable; discontinuous very dark grayish-brown (10YR 3/2) coatings; medium acid; gradual boundary.

B1—13 to 16 inches, brown (10YR 4/3) sandy loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B2t—16 to 28 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, coarse, subangular blocky structure breaking to very weak, medium, subangular blocky structure; friable; discontinuous dark-brown to brown (7.5YR 4/4) clay films; strongly acid; gradual boundary.

B3t—28 to 34 inches, strong-brown (7.5YR 5/6) loamy sand; weak, coarse, subangular blocky structure; very friable; thin patchy clay films; medium acid; clear boundary.

C&B2t—34 to 60 inches, yellowish-brown (10YR 5/6) sand; single grain; loose; ½- to 1-inch dark-brown (7.5YR 4/4) loamy sand bands of clay and iron at depths of 39, 45, 48, 55, and 59 inches; medium acid.

The solum ranges from 24 to 40 inches in thickness. The A1 horizon is very dark grayish-brown (10YR 3/2), dark gray (10YR 4/1), or very dark gray (10YR 3/1). In uneroded areas the A2 horizon ranges from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2) and brown (10YR 5/3). In some places the A2 horizon is wholly incorporated into the Ap horizon. The B2 horizon ranges from sandy loam to light loam and light sandy clay loam. The B horizon has a hue of 10YR to 7.5YR, a value of 4 to 5, and a chroma of 3 to 6. Reaction ranges from medium acid to very strongly acid in the most acid part of the solum.

Lamont soils formed in material similar to that in which Chelsea and Dickinson soils formed. In places they are associated with Burkhardt soils. They have a thinner, lighter colored A horizon than Dickinson soils, and they are not so coarse textured as Chelsea soils. They lack the gravelly B and C horizons that are characteristic of Burkhardt soils.

Lamont fine sandy loam, 2 to 5 percent slopes (110B).—This soil is on stream benches or in convex areas on uplands. It is adjacent to Burkhardt, Chelsea, and Sattre soils and other Lamont soils on stream benches. It is commonly associated with more sloping Chelsea and Lamont soils on uplands. In cultivated areas the plow layer of dark grayish-brown fine sandy loam is much lighter in color when dry.

Included with this soil in mapping are a few areas of soils where depth to gravel is less than 2 feet. Also included are a few areas of nearly level soils that are subject to soil blowing but not to water erosion.

This soil is suited to row crops, but it is droughty unless rain is very timely. If this soil is cultivated, it is subject to slight soil blowing and water erosion. Capability unit IIIe-3; woodland suitability group 3.

Lamont fine sandy loam, 5 to 9 percent slopes (110C).—This soil is on ridges and side slopes on uplands and on benches. It is adjacent to Chelsea and Sattre soils and other Lamont soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is very dark gray and depth to loamy fine sand is shallower.

This soil is suited to row crops, but it is droughty if it is cultivated and soil blowing and water erosion are hazards unless rain is very timely. Most areas of this soil are in pasture and woodland. Capability unit IIIe-3; woodland suitability group 3.

Lawler Series

The Lawler series consists of somewhat poorly drained soils that formed in 24 to 40 inches of loamy alluvial material underlain by coarse-textured material. These soils are either deep and have coarse-textured material at a depth of about 3 feet, or they are moderately deep and have coarse-textured material at a depth of about 2 feet. These soils are nearly level. They are mainly on stream benches, but in a few places they are in small outwash areas on uplands. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown, friable loam about 17 inches thick. The subsoil is mainly dark grayish-brown, friable loam that has mottles in the upper part. It is mottled grayish-brown and yellowish-brown, friable loam in the lower part. The substratum, at a depth of 38 inches, is mottled grayish-brown and yellowish-brown loamy sand that contains some gravel.

Deep Lawler soils have moderate available water capacity, and moderately deep Lawler soils have low to moderate available water capacity. Permeability is moderate in the medium-textured material and rapid in the coarse-textured substratum. These soils are low to medium in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops, but in some years field operations are delayed early in spring because of wetness. In places later in the season these soils, especially the moderately deep soils, are droughty.

Representative profile of Lawler loam, deep, in a pasture, 255 feet east and 400 feet north of the southwest corner of NW¼SW¼ sec. 29, T. 85 N., R. 6 W.:

A1—0 to 11 inches, black (10YR 2/1) loam; weak, fine, granular structure; friable; medium acid; gradual boundary.

A3—11 to 17 inches, very dark grayish-brown (10YR 3/2) loam; very dark gray (10YR 3/1) ped exteriors; weak, fine, subangular blocky structure; friable; common, fine, faint, dark yellowish-brown (10YR 4/4), oxic mottles; medium acid; gradual boundary.

B21—17 to 23 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish-brown (10YR 4/4) mottles; weak, medium, subangular blocky structure; friable; medium acid; gradual boundary.

B22—23 to 30 inches, dark grayish-brown (10YR 4/2) loam; dark-gray (10YR 4/1) ped exteriors; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; friable; few brown and black oxide concretions; strongly acid; gradual boundary.

B3—30 to 38 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) loam; weak, coarse, subangular blocky structure; friable; few brown and black oxide concretions; medium acid; gradual boundary.

IIC—38 to 50 inches, mottled grayish-brown (10YR 5/2) and yellowish-brown (10YR 5/6) loamy sand that contains some gravel; single grain; loose; medium acid.

Depth to coarse-textured material ranges from 24 to 40 inches, which generally is the thickness of the solum. The A horizon is loam or silt loam that is high in content of sand. The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1), and the A3 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A horizon typically ranges from 12 to 18 inches in thickness, but in some areas it ranges to 24 inches, and in these areas colors have a value of 3. The B2 horizon typically is dark grayish brown (2.5Y or 10YR 4/2) and has high-chroma mottles. The B2 horizon typically is heavy loam but ranges from loam to light sandy clay loam. Where depth to sand and gravel is near the minimum for the series, the soil has a IIB3 horizon that formed in coarse material. The IIB3 horizon or the upper part of the C horizon typically ranges from loamy coarse sand to loamy medium gravel. The Lawler soils in this county have dark-gray coatings in the B22 horizon that are grayer than is typical for the series.

Lawler soils are associated with Hayfield, Marshan, Saude, and Waukee soils. They have a thicker, darker colored A horizon than Hayfield soils. They have a grayer B horizon than Saude and Waukee soils and they are not so well drained. They are not so gray in the B horizon as poorly drained Marshan soils.

Lawler loam, deep (0 to 2 percent slopes) (226).—This soil is on stream benches or in outwash areas on uplands. It is commonly adjacent to Hayfield, Marshan, Saude, and Waukee soils and moderately deep Lawler soils. The profile of this soil is the one described as representative for the series. Sand and gravel are at a depth of 32 to 40 inches.

Included with this soil in mapping are a few small areas of soils where the surface layer and the subsoil contain more silt than those in this Lawler soil. Also included are a few areas of soils that have 6 to 20 inches of light-colored overwash.

This soil is well suited to row crops and can be used intensively for corn and soybeans. It is somewhat poorly drained and benefits from tile drainage during wet years. Tile placement is difficult in places because loose, water-bearing sand and gravel are at a depth of about 36 inches. Capability unit I-2; woodland suitability group 7.

Lawler loam, moderately deep (0 to 2 percent slopes) (225).—This soil is on stream benches or in outwash areas on uplands. It is commonly adjacent to Hayfield, Marshan, Saude, and Waukee soils and deep Lawler soils. Sand and gravel are at a depth of 24 to 32 inches.

Included with this soil in mapping are a few small areas of soils where the surface layer and the subsoil contain more silt than those in this Lawler soil. Also included are a few sandy areas that are droughty and less productive than this soil and some wet spots that hinder farming operations at times. These areas are indicated on the soil map by special symbols.

This soil is suited to row crops, and production is good if rain is timely. This soil is either wet or droughty during the growing season, depending on the amount and timeliness of rain. It is somewhat poorly drained and benefits from tile drainage during wet years. Tile placement is difficult because of loose, water-bearing sand and gravel. Capability unit IIs-2; woodland suitability group 7.

Lawson Series

The Lawson series consists of somewhat poorly drained soils that formed in silty alluvium. These soils are nearly level and are on first bottoms or at the base of upland slopes that grade to bottom lands or low benches. The native vegetation was prairie grasses.

In a representative profile the surface layer extends to a depth of 32 inches. It is very dark brown and black silt loam to a depth of 22 inches, and the lower part is very dark gray silt loam that has a few mottles. The subsoil, at a depth of 32 inches, is dark grayish-brown silt loam that has strong-brown mottles.

Lawson soils have moderate permeability and high available water capacity. They are low to medium in available nitrogen and very low in available phosphorus and potassium. These soils are generally neutral in reaction and do not need lime.

These soils are well suited to row crops, but they have a seasonal high water table and are subject to occasional flooding, which, in many areas, determines the extent of their use.

Representative profile of Lawson silt loam, in a level cultivated field, 700 feet north and 560 feet east of the southwest corner of SW¼NE¼ sec. 5, T. 82 N., R. 6 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) silt loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 22 inches, black (10YR 2/1) silt loam, very dark brown (10YR 2/2) when kneaded; weak, fine, granular structure; friable; neutral; clear boundary.

A13—22 to 32 inches, very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) when kneaded; few, fine, distinct, dark-brown (7.5YR 4/4) and strong-brown (7.5YR 5/6) mottles; weak, fine and medium, subangular blocky structure; friable; neutral; clear boundary.

B—32 to 60 inches, dark grayish-brown (10YR 4/2) silt loam; common, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure breaking to weak, fine, subangular blocky structure; friable; neutral.

The solum ranges from about 40 to 60 inches in thickness. The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2), and there is no evidence of recent stratification. The A horizon typically is silt loam that is low in sand, but it ranges to light silty clay loam. In some places, the A horizon contains thin lenses of very fine loamy sand. The B horizon typically is weakly expressed, and hue is 10YR, value is 4 or 5, and chroma is 2 or 3. Where chroma

is 3, mottles are lower in chroma, but the B horizon also contains distinct, higher chroma mottles. The B horizon typically is silt loam but contains thin lenses of fine loamy sand in some places. Reaction is slightly acid to neutral in the most acid part of the solum.

Lawson soils formed in material similar to that in which Colo, Ely, Kennebec, Nodaway, and Spillville soils formed. They are not so fine textured as Ely soils, and they contain less sand than Spillville soils. They are not so fine textured as Colo soils and they are better drained. They are not so stratified in the upper part of the solum as Nodaway soils. They are not so dark colored to as great a depth as Kennebec soils.

Lawson silt loam (0 to 2 percent slopes) (484).—This soil is on bottom lands, on low benches, or in larger upland drainageways. It is commonly adjacent to Colo and Kennebec soils.

Included with this soil in mapping are small areas of soils that have 6 to 20 inches of light-colored recent overwash. Also included are small areas of soils where the subsoil is silty clay loam.

This soil is well suited to row crops if it is properly managed. In some years tile drainage contributes to timely field operations. This soil is subject to floods, especially along the larger streams, and crop production depends on the frequency of floods. Capability unit I-3; woodland suitability group 8.

Loamy Alluvial Land

Loamy alluvial land (315) consists of recently deposited, highly stratified sediment that has not been in place long enough for a uniform sequence of soil horizons to form. The areas are nearly level, many areas are channeled, and low natural levees, small ponds, sloughs, and small oxbows occur. Loamy alluvial land is frequently flooded, and each flood adds new sediment. The sediment is mainly loam, sandy loam, and silt loam.

Because of the hazard of flooding, this land type is not very well suited to cropping and much of it is in permanent pasture. Natural drainage ranges from poor in channels to good on natural levees. Capability unit Vw-1; woodland suitability group 8.

Loamy Terrace Escarpments

Loamy terrace escarpments, 14 to 30 percent slopes (154F) occurs in moderately sloping to very steep areas between stream benches on uplands and bottom lands. The material is dominantly loam and sandy loam. The color of the surface layer ranges from dark to light.

Included with this land type in mapping are areas of gravel or limestone outcrops. These areas are indicated on the soil map by their respective special symbols.

This land type is better suited to trees and wildlife habitat than to most other uses, but some areas are in permanent pasture. It is subject to severe gully erosion. Because it is underlain by sand or gravel, it is droughty. Fertility is generally very low. Capability unit VIIs-1; woodland suitability group 1.

Marsh

Marsh (354) is in depressions in bottom lands that are adjacent to major streams. It is associated with Colo, Marshan, and Muck soils and is intermingled with small ponds. A few areas of Marsh are also in the land-locked depressions of uplands, where Marsh is associated with Bassett, Chelsea, Kenyon, and Sparta soils. The native vegetation was mostly swampgrass, reeds, cattails, and other water-tolerant plants.

Marsh has no distinct soil layers. When the water recedes from the surface, a layer of old plant residue is on the surface. This land type is covered by water most of the time. It is not suited to cultivation and provides poor production for pasture. Areas of Marsh are better suited to wildlife habitat than to most other uses. Capability unit VIIw-1; woodland suitability group 10.

Marshan Series

The Marshan series consists of deep and moderately deep, poorly drained soils. These soils formed in about 24 to 48 inches of moderately fine textured material underlain by coarse-textured material. These soils occur principally on nearly level stream benches, but a few small areas are on uplands where erosional sediment from glacial till occurs. Native vegetation was prairie grasses, sedges, and other water-tolerant plants.

In a representative profile the surface layer is black, friable, silty clay loam about 23 inches thick. The subsoil is dark-gray silty clay loam in the upper 12 inches and mottled olive-gray and yellowish-brown loamy sand and sand.

Deep Marshan soils have moderate to high available water capacity, and moderately deep soils have moderate water capacity. Permeability is moderate in the upper part of the profile and rapid in the sand and gravel. These soils are low to medium in available nitrogen and very low in available phosphorus and potassium. In most places they are neutral in reaction and do not need lime. These soils have a seasonal high water table.

These soils are well suited to row crops if they are drained, but some field operations are delayed because of wetness.

Representative profile of Marshan silty clay loam, deep, in a cultivated field, 400 feet west and 40 feet north of the southeast corner of SW¼SW¼ sec. 11, T. 86 N., R. 5 W.:

Ap—0 to 7 inches, black (10YR 2/1) light silty clay loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A12—7 to 15 inches, black (N 2/0) gritty light silty clay loam; moderate, fine, granular structure; friable; neutral; gradual boundary.

A3—15 to 23 inches, black (10YR 2/1) gritty silty clay loam; few, fine, distinct, dark yellowish-brown (10YR 4/4) mottles; moderate, fine, granular structure; friable; neutral; clear boundary.

B1g—23 to 30 inches, dark-gray (10YR 4/1) gritty silty clay loam; weak, fine, subangular blocky structure; friable; neutral, clear boundary.

B21g—30 to 35 inches, dark-gray (5Y 4/1) gritty silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; few fine pebbles; neutral; clear boundary.

B22g—35 to 40 inches, mottled olive-gray (5Y 5/2) and strong-brown (7.5YR 5/6) medium silty clay loam; weak, medium, subangular blocky structure; friable; slightly acid; clear boundary.

IIB3g—40 to 47 inches, mottled olive-gray (5Y 5/2) and strong-brown (7.5YR 5/8) loam; weak, coarse, subangular blocky structure; friable; slightly acid; clear boundary.

IIC1—47 to 59 inches, olive-gray (5Y 4/2) coarse loamy sand; loose; single grain; neutral.

IIC2—59 to 65 inches, yellowish-brown (10YR 5/4) coarse sand; loose; single grain; slightly acid.

Thickness of the solum and depth to coarse-textured material range from 24 to 48 inches. The A horizon ranges from black (N 2/0) to very dark gray (10YR 3/1) and from 14 to 24 inches in thickness. It typically is gritty silty clay loam but ranges to clay loam and loam. The B horizon has a hue of 5Y, 2.5Y, 7.5YR, or 10YR, a value of 4 or 5, and a chroma of 1, 2, or 6. It is silty clay loam, clay loam, or loam. The IIC horizon in places is loam or sandy loam in the upper part, but gravelly sand, coarse loamy sand, or coarse sand is between depths of 24 and 48 inches. Reaction is slightly acid or neutral in the most acid part of the profile. Marshan silty clay loam, deep, contains slightly less sand and is slightly more than 40 inches to sandy material; however this difference does not affect its usefulness or behavior.

Marshan soils are closely associated with Lawler and Waukee soils and are in the same drainage class as Clyde and Tripoli soils. They have a grayer B horizon and are more poorly drained than Lawler and Waukee soils. They are underlain by sand and gravel rather than by till as are Clyde and Tripoli soils.

Marshan silty clay loam, deep (0 to 2 percent slopes) (152).—This soil is on stream benches and in upland areas where there is erosional sediment from glacial till. It is commonly adjacent to other Marshan soils and to Waukee and Lawler soils. The profile of this soil is the one described as representative for the series. Sand and gravel are generally between depths of 40 and 48 inches, but in a few places they are at a depth of less than 24 inches.

Included with this soil in mapping are small areas of soils where the surface layer and subsoil contain more clay than those in this Marshan soil and small areas of soils that have 6 to 20 inches of light-colored, recent overwash. Also included are spots of Marsh, which are slightly depressional and become ponded unless they are drained. These areas are indicated on the soil map by a special symbol.

This soil is well suited to row crops if it is properly drained. It generally has good tilth, but it puddles if it is worked when wet. Runoff is slow, and some areas of this soil are subject to floods for short duration. Artificial drainage is needed for good crop production. Capability unit IIw-1; woodland suitability group 9.

Marshan silty clay loam, moderately deep (0 to 2 percent slopes) (151).—This soil is on stream benches or in outwash areas on uplands. It is commonly adjacent to Lawler, Saude, and Waukee soils and deep Marshan soils. Sand and gravel are at a depth of 24 to 32 inches.

Included with this soil in mapping are a few small areas of soils where the surface layer and subsoil contain more sand than those in this soil. Also included are spots of Marsh, which are depressional and are ponded part of the year unless they are drained. These areas are indicated on the soil map by spot symbols.

This soil is suited to row crops if it is properly drained. It generally has good tilth but puddles if it is worked when wet. Runoff is slow, and some areas of this soil are subject to flooding for short periods. Because the water table is high, especially in spring, plowing and planting are delayed at times. Tile placement is difficult in some places because of loose, water-bearing sand and gravel. Capability unit IIw-1; woodland suitability group 9.

Maxfield Series

The Maxfield series consists of poorly drained soils that formed in about 24 to 40 inches of loess and glacial till. These soils occur in slight depressions on upland flats or at the head of broad, shallow drainageways. The native vegetation was prairie grasses and sedges.

In a representative profile the surface layer is black silty clay loam about 17 inches thick. The subsoil is about 31 inches thick. The upper 17 inches is very dark brown, dark grayish-brown, and olive-gray silty clay loam that has mottles. The next 3 inches is yellowish-brown loamy sand. The lower 11 inches is yellowish-brown, mottled loam. The substratum, at a depth of 48 inches, is yellowish-brown, mottled, firm loam.

Maxfield soils have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. These soils have high available water capacity. They are medium in available nitrogen and very low in available phosphorus and potassium. They generally are slightly acid to neutral and do not need very much lime.

These soils are well suited to cultivated crops if they are drained.

Representative profile of Maxfield silty clay loam, in a cultivated field, 150 feet west and 160 feet north of the southeast corner of SE¼NW¼ sec. 28, T. 84 N., R. 6 W.:

Ap—0 to 8 inches, black (N 2/0) light silty clay loam; cloddy, breaking to fine granular structure; friable; neutral; clear boundary.

A3—8 to 17 inches, black (N 2/0) light silty clay loam; moderate, fine, granular structure; friable; neutral; clear boundary.

B1—17 to 24 inches, very dark gray (5Y 3/1) and dark grayish-brown (2.5Y 4/2) light silty clay loam; few, fine, faint, light olive-brown (2.5Y 5/4) mottles; weak, fine, subangular blocky structure; friable; few, fine, dark reddish-brown (5YR 2/2) oxide concretions; neutral; clear boundary.

B2g—24 to 34 inches, olive-gray (5Y 4/2) light silty loam; many light olive-brown (2.5Y 5/4) mottles and few, fine, distinct, yellowish-brown (10YR 5/8) mottles; weak, fine, subangular blocky structure; friable; many, fine, dark reddish-brown (5Y 2/2) oxide concretions; neutral; abrupt boundary.

IIB31—34 to 37 inches, yellowish-brown (10YR 5/8) loamy sand; common, fine, distinct, light olive-brown (2.5Y 5/4) mottles; very weak, medium, subangular blocky structure; very friable; few ¼- to 1-inch pebbles; neutral; abrupt boundary.

IIB32—37 to 48 inches, yellowish-brown (10YR 5/8) medium loam; common, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; weak, medium, subangular blocky structure; firm; yellowish-brown (10YR 5/8) sand lens between depths of 47 and 48 inches; mildly alkaline; clear boundary.

IIC1—48 to 60 inches, yellowish-brown (10YR 5/8) loam; common, medium, distinct, light brownish-gray (2.5Y 6/2) mottles; massive; firm; few, fine, dark reddish-brown (5YR 2/2) oxide concretions; moderately alkaline.

The solum typically is about 48 inches thick but ranges from about 40 to 55 inches in thickness. The loess typically is 24 to 40 inches thick but ranges from 20 to 42 inches in thickness. The A horizon is black (N 2/0 or 10YR 2/1) and

and very dark gray (10YR or 5Y 3/1). The upper part of the B horizon has a hue of 2.5Y or 5Y, a value of 3 to 5, and a chroma of 1 or 2. It ranges from heavy silt loam to medium silty clay loam. The IIB3 horizon has a hue of 7.5YR or 10YR, a value of 4 or 5, and a chroma of 3 to 8, but mottles are lower in chroma. The IIB3 horizon typically is loam but ranges to light clay loam and sandy clay loam. A thin layer of loamy sand or sand, typically less than 10 inches thick, commonly separates the loess from the till. The IIC horizon has the same color and texture as the IIB3 horizon. Carbonates are at a depth of about 40 to 60 inches. Reaction typically is neutral, but it is slightly acid in the most acid part of the solum.

Maxfield soils formed in material similar to that in which Dinsdale, Franklin, Klinger, and Waubeek soils formed, and they are associated with Colo and Garwin soils. They have a grayer B horizon and are more poorly drained than Dinsdale, Franklin, Klinger, and Waubeek soils. They have more sand in the lower part of the solum than Garwin soils. They formed in glacial till in the lower part, but Garwin soils formed entirely in loess that is low in content of sand. They have a thinner A horizon than Colo soils.

Maxfield silty clay loam (0 to 2 percent slopes) (382).—This soil is in slight depressions on upland flats or at the heads of broad, shallow drainageways. It is commonly adjacent to other upland soils such as Dinsdale, Garwin, and Klinger and is in drainageways upslope from Colo soils.

Included with this soil in mapping are areas of soils that have 6 to 20 inches of light-colored silty overwash. Also included are a few small areas of soils that formed in a heavier textured till than this Maxfield soil. Permeability is slower in those soils than in this Maxfield soil, and drainage is slower.

This soil is well suited to intensive use for corn and soybeans if it is drained. Capability unit IIw-1; woodland suitability group 9.

Muck

Muck consists of nearly level to gently sloping, very poorly drained organic soils that are mainly 10 to 40 inches deep over alluvial sediment or glacial till. It generally occurs in sidehill seeps or in upland drainageways. A few areas are on stream benches. Native vegetation was grass, sedges, and other water-tolerant plants. Muck is commonly associated with poorly drained Clyde, Colo, Floyd, and Marshan soils.

In a representative profile the surface layer is black organic muck about 15 inches thick. It is underlain by black silty clay loam that grades to olive-gray silty clay loam.

Muck soils have high to very high available water capacity and slow to moderately rapid permeability. They are high in available nitrogen and very low in available phosphorus and potassium. Muck soils are slightly acid to mildly alkaline in reaction. They have a very high water table and a hummocky surface.

If these soils are used for row crops, the area need to be drained and leveled. Considerable settling takes place after these soils are drained.

Representative profile of Muck, shallow, in a permanent pasture, 660 feet west and 132 feet south of the northeast corner of NE¼NE¼ sec. 14, T. 83 N., R. 6 W.:

01l—0 to 10 inches, black (N 2/0) muck; weak, fine, granular structure; very friable; few roots; neutral; gradual boundary.

012—10 to 15 inches, black (N 2/0 to 10YR 2/1) muck that has a few fibers that disintegrate when rubbed; massive; friable; few roots; neutral; clear boundary.

IIC1—15 to 29 inches, black (N 2/0 to 10YR 2/1) silty clay loam; few very dark-gray (10YR 3/1) fibers; massive; friable; neutral; gradual boundary.

IIC2—29 to 32 inches, olive-gray (5Y 5/2) silty clay loam; few very dark grayish-brown (10YR 3/2) fibers; massive; friable; neutral; gradual boundary.

IIC3—32 to 42 inches, light olive-gray (5Y 6/2) light silty clay loam; few, dark yellowish-brown (10YR 4/4) fibers; weakly stratified; friable; neutral.

Muck generally ranges from 10 to 40 inches in thickness, but in places it is as much as 60 inches thick. It is black to very dark brown. The underlying material ranges from black (10YR 2/1) to olive gray (5Y 5/2) and light olive gray (5Y 6/2). Texture of this underlying material varies, but typically it is silty clay loam, loam, or silt loam that contains sandy strata in places. Reaction is typically neutral but ranges from slightly acid to mildly alkaline.

Muck soils are associated with Clyde, Colo, Floyd, and Marshan soils. They have a surface layer of decomposed organic material, more than 10 inches thick, that is absent in Clyde, Colo, Floyd, and Marshan soils. They are also more poorly drained than these soils.

Muck, shallow (1 to 4 percent slopes) (21).—This soil commonly occurs in broad upland drainageways and on lower hillsides that are seepy and wet. In places it is on stream benches. It is commonly associated with Clyde and Floyd soils on uplands and Colo and Marshan soils along stream benches. The profile of this soil is the one described as representative for Muck.

Included with this soil in mapping are areas of soils that have 6 to 20 inches of light-colored overwash. Also included are small areas of soils that have more than 20 inches of organic matter underlain by mineral matter.

This soil is too wet for cropping unless it is drained. If it is drained, it is moderately suited to row crops. It generally is in permanent pasture or is left idle if it is not drained. The water table is at or near the surface during much of the year unless this soil is drained. Outlets for drainage are difficult to obtain in some areas. Capability unit IIIw-1; woodland suitability group 10.

Muck, moderately shallow (1 to 4 percent slopes) (221).—This soil commonly occurs in sidehill seeps at the base of slopes or in upland drainageways. Some areas of this soil are on stream benches. This soil is commonly associated with Clyde and Floyd soils on uplands and Colo and Marshan soils on stream benches.

Included with this soil in mapping are areas that have 6 to 20 inches of light-colored overwash and areas that have as much as 72 inches of mucky peat. The mucky peat areas have a higher percentage of partly decomposed organic material than this Muck soil.

This soil is suited to row crops if it is adequately drained. The water table is at or near the surface much of the year if it is not drained. Tile or surface drainage and leveling of the hummocks are needed before row crops can be grown. Outlets for tile drainage are difficult to obtain in some areas. Capability unit IIIw-1; woodland suitability group 10.

Muscatine Series

The Muscatine series consists of somewhat poorly drained soils that formed in more than 40 inches of

loess. These soils are nearly level on upland divides and are also on some loess-covered stream benches. Native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown and very dark grayish-brown silty clay loam and silt loam about 17 inches thick. The subsoil is dark grayish-brown and grayish-brown and has yellowish-brown mottles. The subsoil is silty clay loam in the upper part and grades to heavy silt loam at a depth of about 40 inches.

Muscatine soils have moderate permeability and high available water capacity. They are low to medium in available nitrogen, low in available phosphorus, and very low in available potassium. These soils are acid where they have not been limed within the last 5 years.

These soils are well suited to corn and soybeans. Some of these soils have a seasonal high water table, and timeliness of field operations can be improved by tile drainage in years of above-normal rain.

Representative profile of Muscatine silty clay loam, 1 to 3 percent slopes, in a cultivated field, 40 feet east and 450 feet south of the northwest corner of NE¼ NE¼ sec. 29, T. 84 N., R. 7 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) light silty clay loam; cloddy, breaking to moderate, fine, granular structure; friable; slightly acid; abrupt boundary.

A12—6 to 11 inches, black (10YR 2/1) heavy silt loam; moderate, fine and medium, granular structure; friable; thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings on peds; medium acid; clear boundary.

A3—11 to 17 inches, very dark grayish-brown (2.5Y 3/2) heavy silt loam; moderate, fine and medium, granular structure; friable; nearly continuous, light brownish-gray (10YR 6/2, dry), grainy coatings on peds; medium acid; gradual boundary.

B1t—17 to 24 inches, dark grayish-brown (2.5Y 4/2) light silty clay loam, common, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, medium, subangular blocky structure breaking to weak, fine, subangular blocky structure; friable; thin discontinuous and very thin patchy clay films on horizontal ped faces; light-gray (10YR 7/2, dry), grainy coatings on peds; medium acid; gradual boundary.

B22t—24 to 32 inches, dark grayish-brown (2.5Y 4/2) medium silty clay loam, common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure breaking to moderate, fine, subangular blocky structure; friable; thin discontinuous clay films; thin, patchy, gray (10YR 6/1), grainy coatings on peds; common fine, dark oxide concretions; medium acid; gradual boundary.

B23—32 to 40 inches, grayish-brown (2.5Y 5/2) light silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, fine and medium, prismatic structure breaking to weak to moderate, fine and medium, subangular blocky structure; friable; few, fine, dark oxide concretions; medium acid; gradual boundary.

B3—40 to 61 inches, grayish-brown (2.5Y 5/2) heavy silt loam; many, fine and medium, distinct, yellowish-brown (10YR 5/6) mottles; medium prismatic structure; friable; thick, continuous, dark-gray (5Y 4/1) and very dark gray (5Y 3/1) clay flows in root channels; few, fine, dark oxide concretions; neutral.

The solum ranges from 50 to 70 inches in thickness. The A horizon ranges from black (10YR 2/1) and very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2 or 2.5Y 3/2). It ranges from 14 to 20 inches in thickness. The B horizon has a hue of 10YR or 2.5Y, a value of 4 to 5, and a chroma of 2, but mottles are higher in chroma. The B2 horizon is about 27 to 35 percent clay. These soils are medium acid to strongly acid in the most acid part of the solum.

Muscatine soils formed in material similar to that in which Atterberry, Garwin, and Tama soils formed, and they are in the same drainage class as Franklin and Klinger soils. They have a darker colored, thicker A horizon than Atterberry soils, and they lack the A2 horizon that is present in Atterberry soils. They have a browner subsoil than poorly drained Garwin soils, but they have a grayer B horizon than well-drained Tama soils. Muscatine soils formed in thicker loess deposits than Franklin and Klinger soils.

Muscatine silty clay loam, 1 to 3 percent slopes (119A).—This soil is on upland divides. It is associated with Atterberry, Garwin, and Tama soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of poorly drained, dark-colored Garwin soils.

This Muscatine soil is well suited to corn and soybeans, and it is used intensively for these crops. It has a seasonal high water table. In places tile is used to drain the head slopes of waterways, and this practice improves the timeliness of field operations in wet years. Capability unit I-2; woodland suitability group 7.

Muscatine silty clay loam, benches, 0 to 2 percent slopes (T119A).—This soil is on loess-covered stream benches. It is adjacent to Atterberry, Tama, and Walford soils on benches. This soil has a profile similar to the one described as representative for the series, it is on lower lying stream benches and is underlain by coarse-textured material at a depth of 48 to 60 inches.

Included with this soil in mapping are a few areas of soils where the surface layer is thinner and lighter colored than this Muscatine soil.

This soil is well suited to row crops if it is properly managed, and crop production generally is above the county average. It commonly receives runoff from adjacent slopes and has a seasonal high water table at times. Tile drainage can improve the timeliness of field operations. In some areas diversions are needed on soils upslope to prevent runoff and siltation. Capability unit I-2; woodland suitability group 7.

Nevin Series

The Nevin series consists of somewhat poorly drained soils that formed in silty clay loam alluvium. These soils are nearly level and are on terraces along major drainageways. Native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark grayish-brown silty clay loam about 23 inches thick. The subsoil is dark grayish-brown and olive-gray, friable silty clay loam that has yellowish-brown mottles in the lower part and extends to a depth of 58 inches.

Nevin soils have high available water capacity and moderate to moderately slow permeability. They are low in available nitrogen, medium to high in available phosphorus, and low to medium in available potassium.

These soils are well suited to row crops and are used intensively for this purpose. Some areas receive runoff from soils upslope. Tile drainage is beneficial in wet years, and farm operations are slightly delayed at times unless tile drains are used.

Representative profile of Nevin silty clay loam, in a cultivated field, 528 feet west and 25 feet south of the northeast corner of NE¼SW¼ sec. 8, T. 82 N., R. 8 W.:

- Ap—0 to 8 inches, black (10YR 2/1) light silty clay loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.
- A12—8 to 15 inches, black (10YR 2/1) light silty clay loam; weak, fine, subangular blocky structure; friable; neutral; gradual boundary.
- A3—15 to 23 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; very dark brown (10YR 2/2) ped exteriors; weak, medium, subangular blocky structure breaking to weak, fine, subangular blocky structure; friable; neutral; gradual boundary.
- B1—23 to 29 inches, dark grayish-brown (10YR 4/2) silty clay loam; weak, fine, subangular blocky structure; friable; discontinuous very dark grayish-brown (10YR 3/2) coatings; few, fine, distinct, olive-brown (2.5Y 4/4) oxide concretions; slightly acid; gradual boundary.
- B2t—29 to 39 inches, dark grayish-brown (2.5Y 4/2) silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; friable; few patchy clay films; few strong-brown (7.5YR 5/6) and dark reddish-gray (5YR 5/2) oxide concretions; neutral; gradual boundary.
- B3—39 to 58 inches, olive-gray (5Y 5/2) light silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure; friable; common, fine, distinct, dark reddish-brown (5YR 3/2) and strong-brown oxide concretions; neutral.

The solum typically is more than 40 inches thick, but it ranges from 36 to 60 inches or more in thickness. The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark brown (10YR 2/2), and very dark grayish brown (10YR 3/2). The A horizon ranges from 18 to 24 inches in thickness, but in a few places it is as much as 30 inches thick. The A horizon typically is light silty clay loam but in places it is silt loam. The B1 and B2 horizons have a hue of 10YR or 2.5Y, a value of 4 or 5, and a chroma of 2 or 3, and they have high-chroma mottles. The B2 horizon is light to medium silty clay loam. The B3 horizon has a hue of 10YR to 5Y, a value of 4 or 5, and a chroma of 2 or 3. Reaction is slightly acid to medium acid in the most acid part of the solum.

Nevin soils are closely associated with Atterberry soils, sandy substratum, and Waukegan soils and are in the same drainage class as Muscatine soils. They have a thicker, darker colored A horizon than Atterberry soils, sandy substratum. Nevin soils formed in alluvium and have a higher content of sand than Muscatine soils, which formed in loess. They have a grayer, more mottled B horizon and are more poorly drained than Waukegan soils.

Nevin silty clay loam (0 to 2 percent slopes) (88).—This soil is on stream benches, dominantly along Cedar River and Prairie Creek. In some areas where this soil is adjacent to uplands, light-colored silty overwash is on the surface.

Included with this soil in mapping are some areas of gently sloping Nevin soils that are subject to slight water erosion.

This soil can be used intensively for row crops, and it is well suited to this use if it is well managed. It is slightly wet but generally does not need tile drainage except in wet years. Diversion terraces placed on adjacent upland slopes protect it from overflow and silting. Capability unit I-2; woodland suitability group 7.

Nodaway Series

The Nodaway series consists of moderately well drained soils that formed in recently deposited silty alluvium. These soils are stratified, because each flood deposits fresh sediment on the surface. They are nearly level on flood plains and nearly level to gently sloping on alluvial fans and narrow upland waterways that are associated with steep loess soils.

In a representative profile the plow layer is very dark grayish-brown silt loam about 6 inches thick. Below this is dark grayish-brown, very dark gray, and grayish-brown, stratified, friable silt loam that extends to a depth of 64 inches. A very dark gray silty clay loam buried soil is at a depth below 64 inches.

Nodaway soils have moderate permeability and high available water capacity. They are low in available nitrogen and medium in available phosphorus and potassium. They are generally neutral in reaction and do not need lime.

These soils are well suited to corn and soybeans. They have a seasonal high water table and are subject to overflow. In some years crops are damaged by floods.

Representative profile of Nodaway silt loam, 0 to 2 percent slopes, in a level, cultivated field, 450 feet south and 20 feet east of the northwest corner of NW¼NW¼ sec. 32, T. 82 N., R. 5 W.:

- Ap—0 to 6 inches, very dark grayish-brown (10YR 2/2) silt loam; weak, very fine, granular structure; friable; neutral; abrupt boundary.
- C—6 to 64 inches, stratified dark grayish-brown (10YR 4/2), very dark gray (10YR 3/1), and grayish-brown (10YR 5/2) silt loam; common, fine, faint, distinct, brown (7.5YR 4/4) mottles at a depth of 34 to 64 inches; massive; friable; few very dark brown (10YR 2/2) oxide concretions; thin strata of yellowish-brown (10YR 5/4) coarse silt loam at a depth of 12 to 30 inches; neutral; clear boundary.
- IIA1b—64 to 69 inches, very dark gray (10YR 3/1) light silty clay loam; common, fine, distinct, dark-brown (7.5YR 3/2) mottles; massive; firm; neutral.

The A1 horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2), is 6 to 10 inches thick, and commonly is stratified. In cultivated areas the Ap horizon is very dark grayish brown (10YR 3/2). The C horizon dominantly has a hue of 10YR, a value of 3 to 5, and a chroma of 2 or 3, but some strata have a chroma of 1. Dark, medium-textured or moderately fine textured buried soils are below a depth of 40 inches in places. The C horizon typically is silt loam, but some layers are light silty clay loam. Thin lenses of material coarser than silt loam are at a depth of less than 40 inches. Sandy material is at a depth below 40 inches in some places. Reaction is slightly acid to neutral throughout the profile.

Nodaway soils formed in material similar to that in which Colo, Kennebec, Lawson, and Spillville soils formed. They are lighter colored and are more stratified than Colo, Kennebec, and Lawson soils. They are lower in clay content and better drained than Colo soils, and they contain more silt and less sand than Spillville soils.

Nodaway silt loam, 0 to 2 percent slopes (220A).—This soil is mainly on bottom lands. It is also in narrow upland waterways or on alluvial fans downslope from Downs, Fayette, or Seaton soils. It is commonly adjacent to other bottom-land soils such as Colo, Kennebec, or Lawson. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of soils that have 6 to 20 inches of sandy overwash. Also included are a few areas of soils that are underlain by a dark-colored buried soil at a depth of less than 36 inches.

This soil is suited to intensive use for corn and soybeans. Areas of this soil that are inaccessible or that are

in narrow drainageways are generally in permanent pasture or woodland. Areas of bottom lands are small and irregular. They commonly are farmed with adjoining soils. This soil is subject to overflow during periods of heavy rain, and crop damage results in some years. It has a seasonal high water table. In some areas it is dissected by old stream channels, which makes accessibility difficult. Capability unit I-3; woodland suitability group 8.

Nodaway silt loam, 2 to 5 percent slopes (220B).—This soil is on flood plains, in narrow upland waterways, and on alluvial fans below Downs, Fayette, or Seaton soils. It is commonly adjacent to Colo soils. This soil has a profile similar to the one described as representative for the series, but it typically occurs only in narrow, more sloping valleys.

Included with this soil in mapping are areas of soils that are underlain by a dark-colored buried soil at a depth of less than 36 inches.

This soil is suited to row crops, but many areas are small and irregular and are farmed with adjoining soils or left in grassed waterways. Inaccessible areas along narrow drainageways are left in permanent pasture or in woodland. This soil is subject to high-velocity, short-duration floods. Seepage from upland soils makes this soil seasonally wet, and in some of these areas tile drainage is needed to permit timely field operations. Some areas are dissected by gullies or by numerous waterways. Capability unit IIe-4; woodland suitability group 8.

Olin Series

The Olin series consists of well-drained soils that formed in 20 to 36 inches of sandy loam and underlying glacial till. These soils are gently sloping to moderately sloping and are on uplands. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and very dark grayish-brown fine sandy loam about 23 inches thick. The upper 8 inches of the subsoil is brown sandy loam, and the lower 21 inches is dark yellowish-brown and yellowish-brown loam. The substratum, at a depth of 52 inches, is yellowish-brown, mottled, firm loam that is calcareous at a depth below 65 inches.

Olin soils are moderately rapidly permeable in the upper part of the profile and moderately slowly permeable in the lower part, which formed in glacial till. Available water capacity is moderate. These soils are low in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops, but they are droughty during some years of low rainfall. Soil blowing is a hazard if the soils are bare. Because of the difference in permeability in the upper and lower parts of the profile, water accumulates at the till contact in periods of heavy rainfall and seepy spots tend to develop.

Representative profile of Olin fine sandy loam, 2 to 5 percent slopes, in a cultivated field, 150 feet east and 150 feet south of the northwest corner of SW¼NE¼ sec. 1, T. 86 N., R. 7 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) fine sandy loam; cloddy, breaking to weak, fine, granular structure; very friable; slightly acid; clear boundary.

A12—7 to 14 inches, very dark brown (10YR 2/2) fine sandy loam; weak, fine, subangular blocky structure breaking to weak, fine, granular structure; very friable; medium acid; gradual boundary.

A3—14 to 23 inches, very dark grayish-brown (10YR 3/2) fine sandy loam; weak, medium, subangular blocky structure breaking to weak, fine, subangular blocky structure; very friable; medium acid; gradual boundary.

B21—23 to 31 inches, brown (10YR 4/3) sandy loam; weak, medium, subangular blocky structure; very friable; very dark grayish-brown (10YR 3/2) coatings in upper part; band of pebbles at a depth of 31 inches; medium acid; gradual boundary.

IIB2—31 to 38 inches, dark yellowish-brown (10YR 4/4) heavy loam; few, fine, distinct, strong-brown (7.5YR 5/8) mottles; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; firm; discontinuous grayish-brown (10YR 5/2) coatings; few, fine, dark reddish-brown (5YR 3/2) oxide concretions; medium acid; gradual boundary.

IIB3—38 to 52 inches, yellowish-brown (10YR 5/6) heavy loam; grayish-brown (2.5Y 5/2) ped exteriors; few, fine, distinct, gray (5Y 5/1) mottles; weak, coarse, prismatic structure; firm; common, fine, strong-brown (7.5YR 5/6) oxide concretions; medium acid; gradual boundary.

IIC1—52 to 65 inches, yellowish-brown (10YR 5/6) loam; common, fine, distinct, gray (5Y 5/1) mottles; massive; firm; common, fine, strong-brown (7.5YR 5/6) and dark reddish-brown (5YR 3/2) oxide concretions; medium acid; gradual boundary.

IIC2—65 to 80 inches, yellowish-brown (10YR 5/6) loam; many, fine, distinct, gray (5Y 5/1) mottles; massive; firm; common, fine, strong-brown (7.5YR 5/6) and dark reddish-brown (5YR 3/2) oxide concretions; calcareous.

The solum ranges from 40 to 60 inches in thickness. The Ap horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2), and the A12 horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon ranges from 14 to 24 inches in thickness, and thickness commonly decreases as slope increases. The B2 horizon has a hue of 10YR, a value dominantly of 3 to 5, and a chroma of 3 or 4. In places a dark-brown (10YR 3/3) or brown (10YR 4/3) B1 horizon is present. The B2 horizon typically is sandy loam, but layers of loamy sand 6 to 8 inches thick are present in some areas. A band of pebbles is in the lower part of the B2 horizon or in the upper part of the IIB2 horizon. The IIB horizon has a hue of 10YR, a value of 3 to 5, and a chroma of 3 to 6. In the lower part of some B horizons, at a depth below 30 inches, mottles have a chroma of 2 or lower. These mottles increase in size and number as depth increases. The IIB2 horizon is commonly heavy loam but ranges to medium loam, light clay loam, or sandy clay loam. The IIC horizon has a hue of 10YR or 7.5YR, a value of 4 to 6, and a chroma of 4 to 8, and there are some grayish mottles. Depth to carbonates ranges from 50 to 80 inches. Reaction is medium acid to strongly acid in the most acid part of the solum.

The Olin soils formed in material similar to that in which Dickinson soils, loam substratum, formed, and they are associated with Dickinson, Kenyon, and Sparta soils. They are shallower to glacial till than Dickinson soils, loam substratum. They contain more sand in the upper part of the solum than Kenyon soils, and they contain less sand than Sparta soils.

Olin fine sandy loam, 2 to 5 percent slopes (408B).—This soil is on glaciated uplands. It is commonly associated with Dickinson, Kenyon, and Sparta soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of soils where the sandy loam texture is less than 20 inches thick. Also included are small areas of nearly level soils.

This soil is suited to row crops if it is well managed. The surface layer is easy to work and dries out quickly in spring. This soil is droughty in some years, however, because of the difference in permeability in the upper and

lower parts of the profile. In periods of heavy rain, water tends to accumulate at the till contact and then moves laterally, which results in seepy areas. Capability unit IIe–2; woodland suitability group 3.

Olin fine sandy loam, 5 to 9 percent slopes (408C).—This soil is on narrow ridges and side slopes on uplands. It is commonly associated with Dickinson and Kenyon soils. This soil has a profile similar to the one described as representative for the series, but the dark surface layer is not so thick and depth to loam till is shallower.

Included with this soil in mapping are areas of soils where the sandy loam texture is less than 20 inches thick.

This soil is suited to row crops if it is well managed. The surface layer is easy to work and dries out quickly in spring. This soil is droughty in some years, however, because of the difference in permeability in the upper and lower parts of the profile. In periods of heavy rain, water tends to accumulate at the till contact and then moves laterally, which results in seepy, wet areas. This soil is subject to soil blowing and water erosion. Capability unit IIIe–1; woodland suitability group 3.

Oran Series

The Oran series consists of somewhat poorly drained soils that formed in 14 to 24 inches of loamy material and underlying glacial till. In most places a layer of pebbles and stones is at the contact of the loamy material and the glacial till. These soils are nearly level to gently sloping in concave areas on uplands. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 8 inches thick. The subsurface layer is dark grayish-brown, friable loam about 4 inches thick. The upper part of the subsoil, to a depth of 23 inches, is dark grayish-brown loam that has yellowish-brown mottles. The lower part is mottled grayish-brown, strong-brown, and yellowish-brown heavy loam. The substratum, at a depth of 52 inches, is mottled light grayish-brown and yellowish-brown heavy loam.

Oran soils have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. Water moves through the upper part of this soil and accumulates at the till contact, resulting in a seasonal perched water table. These soils have high available water capacity. They are low in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops if they are properly managed.

Representative profile of Oran loam, 0 to 2 percent slopes, in a cultivated field, 200 feet north and 100 feet east of the southwest corner of NW¼NW¼ sec. 12, T. 85 N., R. 8 W.:

Ap—0 to 8 inches, very dark brown (10YR 2/2) loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—8 to 12 inches, dark grayish-brown (10YR 4/2) loam; weak, thin, platy structure; friable; strongly acid; clear boundary.

B1—12 to 23 inches, dark grayish-brown (10YR 4/2) loam; common, fine, faint, yellowish-brown (10YR 5/6) mottles; weak, fine, subangular blocky structure; friable; discontinuous grainy coatings on faces of peds; band of pebbles at a depth of 23 inches; strongly acid; clear boundary.

IIB2t—23 to 36 inches, mottled grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) medium loam; weak, medium, subangular blocky structure; friable; thin discontinuous clay films; thin, discontinuous, gray (10YR 7/2), grainy coatings; stones and pebbles at a depth of 23 inches; strongly acid; gradual boundary.

IIB3t—36 to 52 inches, mottled light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/6) heavy loam; weak, medium, prismatic structure; firm; few, thin, discontinuous clay films; thin, discontinuous, gray (10YR 7/2), grainy coatings; medium acid; gradual boundary.

IIC—52 to 60 inches, mottled light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/6) heavy loam; massive; firm; moderately alkaline.

The solum typically is more than 48 inches thick but ranges from about 40 to 60 inches in thickness. The Ap horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The A2 horizon ranges from 3 to 6 inches in thickness. The A horizon is loam or silt loam containing a noticeable amount of sand. Depth to the stone line, or the IIB horizon, ranges from 14 to 24 inches. The B horizon has a hue of 10YR or 2.5Y, a value of 4 or 5, and a chroma of 2. Mottles in the upper part of the B horizon are higher in chroma than the B horizon. Where present, mottles in the lower part of the B horizon have a value of 4 or 6 and a chroma of 2 to 6. The B horizon ranges from medium to light clay loam and sandy clay loam. Depth to carbonates generally corresponds to the thickness of the solum. Reaction is strongly acid to very strongly acid in the most acid part of the solum.

The Oran soils formed in material similar to that in which Bassett, Kenyon, Readlyn, and Tripoli soils formed, and they are in the same drainage class as Floyd, Franklin, and Schley soils. They have a grayer B horizon and are more poorly drained than Bassett and Kenyon soils. They have a browner B horizon and are better drained than Tripoli soils. They are also lighter colored than Tripoli and Floyd soils. Oran soils are shallower to glacial till than Franklin and Schley soils, and they lack the coarse-textured layers that are present in Schley soils.

Oran loam, 0 to 2 percent slopes (471A).—This soil is on upland ridges or in drainageways. It is commonly associated with Bassett, Clyde, Readlyn, and Schley soils. The profile of this soil is the one described as representative for the series.

This soil is suited to intensive use for row crops. It has a seasonal high water table because of moderately slow permeability in the glacial material. Tile drainage is beneficial in wet seasons, and it improves the timeliness of field operations. Capability unit I–2; woodland suitability group 7.

Oran loam, 2 to 5 percent slopes (471B).—This soil is commonly on side slopes and at the head of drainageways. It is generally associated with Bassett, Clyde, and Kenyon soils. This soil has a profile similar to the one described as representative for the series, except that depth to underlying glacial till is shallower.

This soil is well suited to row crops. It is subject to slight erosion if it is cultivated. The long, uniform, upland slopes are well suited to contouring and terracing, but these practices slow down movement of surface water and let more water soak into the soil. The extra water entering the soil complicates drainage, especially in wet years. Because providing adequate drainage and controlling erosion are difficult, a combination of the drainage and terracing is needed in places. Capability unit IIe–3; woodland suitability group 7.

Readlyn Series

The Readlyn series consists of somewhat poorly drained soils that formed in 14 to 24 inches of loamy material and underlying glacial till. In most places a layer of pebbles and stones is at the contact of the loamy material and the glacial till. These soils are nearly level where they occur at the head of upland drainageways and in other areas on uplands. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is about 18 inches of black, very dark brown, and very dark grayish brown loam. The subsoil is dark grayish-brown heavy loam in the upper 7 inches and grades to yellowish-brown, firm heavy loam in the lower part of the subsoil and in the substratum.

Readlyn soils have high available water capacity. They have moderate permeability in the loamy material and moderately slow permeability in the glacial till. They are low to medium in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed in the last 5 years.

These soils are well suited to row crops. Some areas have a seasonal high water table, and these areas benefit from tile drainage.

Representative profile of Readlyn loam, 0 to 2 percent slopes, in a cultivated field, 280 feet south and 260 feet west of the northeast corner of SW¼NE¼ sec. 13, T. 88 N., R. 8 W.:

Ap—0 to 7 inches, black (10YR 2/1) loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A12—7 to 13 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; medium acid; gradual boundary.

A3—13 to 18 inches, very dark grayish-brown (10YR 3/2) loam; weak, fine, subangular blocky structure; friable; strongly acid; gradual boundary.

IIB21—18 to 25 inches, dark grayish-brown (2.5Y 4/2) heavy loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure breaking to weak, fine, subangular blocky structure; firm; few pebbles at a depth of 18 inches; strongly acid; gradual boundary.

IIB22—25 to 34 inches, dark yellowish-brown (10YR 4/4) and grayish-brown (2.5Y 5/2) heavy loam; common, fine, distinct, yellowish-brown (10YR 5/6) and light-gray (10YR 7/2) mottles; weak, coarse, prismatic structure breaking to moderate, fine, subangular blocky structure; firm; medium acid; gradual boundary.

IIB22—34 to 48 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) and light-gray (10YR 7/2) mottles; weak, coarse, prismatic structure breaking to moderate, fine, subangular blocky structure; firm; very few thin clay films in a few pores; few black oxide concretions; slightly acid; gradual boundary.

IIC—48 to 60 inches, yellowish-brown (10YR 5/6) heavy loam; many, fine, distinct, grayish-brown (2.5Y 5/2) mottles; massive; firm; mildly alkaline.

The solum typically is 40 to 60 inches thick. The A horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in the upper part and very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) in the lower part. The A horizon ranges from about 15 to 20 inches in thickness. It typically is loam but ranges to light silty clay loam or heavy silt loam that is high in content of sand. The B horizon has a hue of 10YR or 2.5Y, a value of 4 or 5, and a chroma of 2 to 8. Mottles are present throughout the B horizon. The IIB and IIC horizons are heavy loam, light clay loam, or sandy clay loam. Depth to carbonates commonly is the same as the thickness of the solum. Reaction is medium acid to strongly acid in the most acid part of the solum.

Readlyn soils formed in material similar to that in which Kenyon, Oran, and Tripoli soils formed, and they are associated with Clyde, Floyd, and Schley soils. They have a thicker, darker colored A horizon than Oran and Schley soils. They have a grayer subsoil and are more poorly drained than Kenyon soils. They are less gray and are better drained than Tripoli soils. They are shallower to firm loam till than Floyd and Clyde soils, and they are not so poorly drained as Clyde soils.

Readlyn loam, 0 to 2 percent slopes (399A).—This soil is on upland flats or at the heads of drainageways. It is associated with Clyde, Floyd, Kenyon, Schley, and Tripoli soils.

Included with this soil in mapping are a few areas of soils where the depth to glacial till is more than 24 inches, also included are a few wet areas, which are indicated on the soil map by a special symbol. The wet areas hinder farming operations unless they are drained.

This soil is well suited to intensive use for corn and soybeans. It has a seasonal high water table and benefits from tile drainage in some years. Capability unit I-2; woodland suitability group 7.

Richwood Series

The Richwood series consists of well-drained soils that formed in silty alluvium. These soils are nearly level and are on benches along major streams in the county. The native vegetation was prairie grasses.

In a representative profile the surface layer is silt loam about 20 inches thick. It is black and very dark brown in the upper 14 inches and grades to very dark grayish brown in the lower part. The upper part of the subsoil is brown and dark yellowish-brown, friable silt loam that extends to a depth of 57 inches. The lower part of the subsoil is brown, friable loam.

Richwood soils have moderate permeability and high available water capacity. These soils generally are high in content of organic matter. They are low to medium in available nitrogen, low in available phosphorus, and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops.

Representative profile of Richwood silt loam, in a cultivated field, 535 feet east and 330 feet south of the northwest corner of SE¼SE¼ sec. 33, T. 82 N., R. 5 W.:

Ap—0 to 7 inches, black (10YR 2/1) silt loam, slightly higher chroma when kneaded; cloddy, breaking to weak, fine, subangular blocky structure; friable; slightly acid; clear boundary.

A12—7 to 14 inches, very dark brown (10YR 2/2) silt loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

A3—14 to 20 inches, very dark grayish-brown (10YR 3/2) silt loam, some dark-brown to brown (10YR 4/3) material from B21 horizon; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21—20 to 30 inches, brown (10YR 4/3) silt loam; moderate, fine and medium, subangular blocky structure; friable; discontinuous dark-brown (10YR 3/3) ped coatings; few, thin, patchy, gray (10YR 6/1, dry), grainy coatings; medium acid; gradual boundary.

B22t—30 to 39 inches, dark yellowish-brown (10YR 4/4) silt loam; brown (10YR 4/3) ped exteriors; weak, fine, prismatic structure breaking to weak, moderate, subangular blocky structure; friable; few, thin, patchy, dark yellowish-brown (10YR 3/4) clay films; few, thin, patchy,

gray (10YR 6/1, dry), grainy coatings; medium acid; gradual, smooth boundary.

B31t—39 to 57 inches, dark yellowish-brown (10YR 4/4) silt loam; brown (10YR 4/3) ped exteriors; moderate, medium, prismatic structure breaking to weak, medium and coarse, subangular blocky structure; friable; thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films, clay films are concentrated between depths of 40 and 42 inches but are in pores and on some prism faces throughout; thin, light-gray (10YR 7/1, dry), grainy coatings are nearly continuous on some prisms to discontinuous on blocky peds; sand content increases as depth increases; medium acid; gradual boundary.

IIB32t—57 to 64 inches, brown (10YR 4/3) loam; weak, prismatic structure breaking to weak, fine and medium, subangular blocky structure; friable; few, thin, patchy clay films on some prisms and in pores; nearly continuous, light-gray (10YR 7/2, dry), grainy coatings; sand content increases as depth increases in horizon; medium acid.

The solum ranges from 45 inches to more than 65 inches in thickness. The A1 horizon ranges from black (10YR 2/1) or very dark brown (10YR 2/2) to very dark grayish brown (10YR 3/2). The A horizon is light to medium silt loam. Colors that have a value and chroma of 3 or less are typically at a depth of 14 to 20 inches, but in places they extend to as deep as 24 inches. The B2 horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. The B2 horizon ranges from medium silt loam to light silty clay loam, and clay content ranges from about 22 to 28 percent. Content of sand in the B3 horizon typically increases with depth, and texture typically is silt loam to loam. In places sandy loam is at a depth below 50 inches. Reaction is medium acid to strongly acid in the most acid part of the solum.

Richwood soils formed in material similar to that in which Bertrand, Lawson, Nevin, and Waukegan soils formed. They have a darker colored A horizon than Bertrand soils. They do not have a contrasting texture of sand or loamy sand at a depth of less than 40 inches, which is characteristic of Waukegan soils. They have a browner B horizon and are better drained than Lawson and Nevin soils.

Richwood silt loam (0 to 2 percent slopes) (977).—This soil is at the mouth of upland drainageways that fan out onto stream benches, mainly along the Cedar River. It is associated with Lawson, Nevin, and Waukegan soils. The surface layer is high in content of organic matter, has granular structure, and is in good tilth.

Included with this soil in mapping are some areas of nearly level to gently sloping soils that are lighter colored and lower in content of organic matter than this Richwood soil. Also included are areas of soils where the surface layer is thicker than that of this soil, and the areas are subject to occasional floods.

The soil is well suited to intensive use for row crops if good management is used. It is easily tilled, and control of erosion is not a concern. In some areas properly placed diversion terraces are needed to protect this soil from siltation from higher lying soils. Capability unit I-1; woodland suitability group 1.

Rockton Series

The Rockton series consists of well-drained soils that formed in 20 to 40 inches of loamy material and a thin layer of limestone residium underlain by limestone bedrock. These soils are gently sloping on high ridges and gently sloping to strongly sloping on side slopes on uplands. Native vegetation was mixed prairie grasses.

In a representative profile the surface layer is black loam about 14 inches thick. The subsoil is clay loam that is very dark grayish brown in the upper 5 inches and brown in the lower 17 inches. The substratum is partly weathered, shattered limestone bedrock that has thin rinds of clay residuum between the rocks.

Rockton soils have moderate to low available water capacity and moderate permeability. They are low in available nitrogen and very low in available phosphorus and potassium. They are acid and need lime where they have not been limed within the last 5 years.

These soils are suited to row crops, but they tend to be droughty unless rain is timely.

Representative profile of Rockton loam, deep, 2 to 5 percent slopes, in a cultivated field, 560 feet west and 280 feet south of the northeast corner of SE¼NW¼ sec. 22, T. 84 N., R. 7 W.:

Ap—0 to 9 inches, black (10YR 2/1) medium loam; weak, fine, granular structure; friable; neutral; gradual boundary.

A3—9 to 14 inches, black (10YR 2/1) heavy loam, very dark brown (10YR 2/2) when kneaded; weak, fine, granular and subangular blocky structure; friable; slightly acid; gradual boundary.

B1—14 to 19 inches, very dark grayish-brown (10YR 3/2) clay loam; weak, fine to medium, subangular blocky structure; friable; slightly acid; gradual boundary.

B21t—19 to 23 inches, brown (10YR 4/3) clay loam; weak, medium, subangular blocky structure breaking to weak, fine, subangular blocky structure; firm; thin discontinuous clay films; medium acid; gradual boundary.

B22t—23 to 36 inches, brown (10YR 4/3) clay loam; weak to moderate, medium, subangular blocky structure; firm; few fine limestone pebbles; thin discontinuous clay films; slightly acid; abrupt boundary.

IIR—36 inches, partly weathered and shattered limestone bedrock that has clay residuum between the rock fissures.

Thickness of the solum and depth to limestone bedrock ranges from 20 to 40 inches. The A horizon has a hue of 10YR, a value of 2 or 3, and a chroma of 1 or 2. It is 10 to 18 inches thick. It typically is loam, but in places it is silt loam. The B2t horizon has a value of 4 or 5, a chroma of 3 to 6, and a hue of 10YR in the upper part and a hue of 7.5YR or 10YR in the lower part. The B2t horizon is about 25 to 35 percent clay. The IIB horizon, or residuum, where present, is either as much as 6 inches thick or is in the form of rinds around limestone flagstones. It is heavy clay loam, clay, or silty clay. Reaction is medium acid to strongly acid in the most acid part of the solum.

Rockton soils formed in material similar to that in which Aredale, Kenyon, Sogn, and Whalan soils formed. They have limestone bedrock at a depth of 20 to 40 inches, but bedrock is lacking in Aredale and Kenyon soils. They are deeper over bedrock than Sogn soils. They have a thicker, darker colored A horizon than Whalan soils.

Rockton loam, deep, 2 to 5 percent slopes (213B).—This soil is on narrow ridges or on the high part of benchlike areas, and depth to limestone is typically 30 to 40 inches. It is above more sloping deep Rockton soils. It commonly is associated with Kenyon soils or moderately deep Rockton soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of soils where the surface layer is thinner and lighter colored than that of this Rockton soil and the subsurface layer is light colored. A few areas of less sloping soils are also included. In some areas limestone outcrops are on the surface. These areas are indicated on the soil map by a special symbol.

This soil is suited to row crops, but it is droughty if rain is not timely. Terrace construction is difficult in some

areas because of shallowness to bedrock. Capability unit IIe-1; woodland suitability group 3.

Rockton loam, deep, 5 to 9 percent slopes (213C).—This soil is on convex side slopes or on the high part of benchlike areas, and depth to limestone is typically 30 to 40 inches. It is below Sogn soils and other deep Rockton soils. It is commonly associated with Kenyon soils and moderately deep Rockton soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is not so thick.

Included with this soil in mapping are small areas of eroded soils where the plow layer is a mixture of material originally in the surface layer and some of the material in the subsoil. This plow layer is lower in content of organic matter than that of this Rockton soil. Also included are some areas of limestone outcrops which hinder farming operations. These areas are indicated on the soil map by a special symbol.

This soil is suited to row crops, but it is erodible if it is cultivated. It is droughty at times if rain is not timely. Terrace construction is difficult in some areas because of shallowness to bedrock. Capability unit IIIe-1; woodland suitability group 3.

Rockton loam, moderately deep, 2 to 5 percent slopes (214B).—This soil is on narrow ridges or on the high part of benchlike areas. It is above more sloping moderately deep Rockton soils. It is commonly associated with Kenyon soils and deep Rockton soils. This soil has a profile similar to the one described as representative for the series, except that limestone generally is at a depth of 20 to 30 inches.

Included with this soil in mapping are small areas of soils where the surface layer is thinner and lighter colored than that of this Rockton soil, and the subsurface layer is light colored. A few areas of nearly level soils are also included. Also included are some areas of limestone outcrops, which hinder farming operations. These areas are indicated on the soil map by a special symbol.

This soil is suited to row crops, but it is droughty in years of average or below-average rain. Because of shallowness to bedrock, this soil has a limited root zone and is not well suited to terraces. This soil is subject to erosion if it is cultivated. Capability unit IIe-2; woodland suitability group 3.

Rockton loam, moderately deep, 5 to 9 percent slopes (214C).—This soil is on convex side slopes or on the high part of benchlike areas. It is below other Rockton soils and above Sogn soils. This soil has a profile similar to the one described for the series, but the surface layer generally is not so thick and limestone generally is at a depth of 20 to 30 inches.

Included with this soil in mapping are some areas of limestone outcrops, which hinder farming operations. These areas are indicated on the soil map by a special symbol.

This soil is suited to row crops, but it is droughty in years of average or below-average rainfall. Because of shallowness to bedrock, this soil has a limited root zone and is not well suited to terraces. This soil is subject to erosion if it is cultivated. Capability unit IIIe-4; woodland suitability group 3.

Rockton loam, moderately deep, 9 to 14 percent slopes (214D).—This soil is on convex side slopes or at the base of side slopes. It is below less sloping Rockton soils and upslope from areas of steep Sogn soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner and depth to limestone is shallower.

Included with this soil in mapping are small areas of soils where the surface layer is lighter colored and lower in content of organic matter than that of this Rockton soil. Also included are many areas of limestone outcrops, which hinder farming operations. These areas are indicated on the soil map by a special symbol. In these areas, depth to bedrock generally is 20 to 30 inches, but it is more variable than in less sloping Rockton soils.

This soil is better suited to hay and pasture than to row crops. Productivity is low, and this soil tends to be droughty, even in years of average rain. Capability unit IVe-2; woodland suitability group 3.

Sattre Series

The Sattre series consists of well-drained soils that formed in loamy alluvium. They are underlain by sand or gravel at a depth of about 32 to 40 inches. These soils are nearly level to moderately sloping and are on stream benches and on uplands. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown loam about 9 inches thick. The subsurface layer is dark grayish-brown, friable loam about 4 inches thick. The subsoil is brown and dark yellowish-brown, friable loam in the upper 21 inches and dark yellowish-brown, very friable sandy loam in the lower 3 inches. The substratum is yellowish-brown fine sand and strong-brown loamy sand.

Sattre soils have moderate permeability in the medium-textured material and rapid to very rapid permeability in the coarse-textured substratum. These soils have medium available water capacity. They are low in available nitrogen and phosphorus and very low in available potassium. They are acid where they have not limed within the last 5 years.

These soils are well suited to row crops, but they tend to be somewhat droughty during years of below-normal rain.

Representative profile of Sattre loam, 0 to 2 percent slopes, in a permanent pasture, 150 feet north and 40 feet west of the southeast corner of NE¼SW¼ sec. 30, T. 84 N., R. 6 W.:

A1—0 to 9 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; slightly acid; clear boundary.

A2—9 to 13 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak, medium, platy structure breaking to weak, fine, subangular blocky structure; friable; few very dark grayish-brown coatings on peds; nearly continuous, light-gray (10YR 7/1, dry) coatings; slightly acid; clear boundary.

B1—13 to 19 inches, brown (10YR 4/3) loam; weak, fine, subangular blocky structure; friable; discontinuous, very dark grayish-brown (10YR 3/2) coatings on peds, nearly continuous, light-gray (10YR 7/1, dry), grainy coatings; slightly acid; gradual boundary.

B21t—19 to 29 inches, brown (10YR 4/3) heavy loam; moderate, fine, subangular blocky structure; friable; thin discontinuous clay films; discontinuous, light-gray (10YR 7/1, dry), grainy coatings; medium acid; gradual boundary.

B22t—29 to 34 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, subangular blocky structure; friable; few, thin, discontinuous clay films; few, light-gray (10YR 7/1, dry), grainy coatings; strongly acid; clear boundary.
B3—34 to 37 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, coarse, subangular blocky structure; very friable; strongly acid; gradual boundary.
IIC1—37 to 58 inches, yellowish-brown (10YR 5/4) fine sand; single grained; loose; strongly acid; clear boundary.
IIC2—58 to 62 inches, strong-brown (7.5YR 5/6) loamy sand; single grained; loose; strongly acid.

The solum ranges from about 30 to 50 inches in thickness. Thickness of the solum in places corresponds with depth to contrasting texture of loamy sand or sand. Depth to these materials ranges from 32 to 40 inches. The A1 or Ap horizon typically is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or very dark gray (10YR 3/1). It ranges from 6 to 10 inches in thickness. The A2 horizon commonly is brown (10YR 4/3 or 5/3) or dark grayish brown (10YR 4/2). In some eroded areas the A2 horizon is wholly incorporated into the Ap horizon. The B2 horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 8. The B2 horizon is loam, light clay loam, or light sandy clay loam that grades to sandy loam or loamy sand in the B3 horizon. Clay content of the B2 horizon ranges from 18 to 22 percent. The C horizon has a hue of 10YR or 7.5YR, a value of 4 to 6, and a chroma of 3 to 8. It ranges from loamy sand to sand that contains some gravel. The content of gravel ranges from a little in some places to as much as 20 to 30 percent, by volume, in some strata.

Sattre soils formed in material similar to that in which Hayfield, Lawler, Saude, Wapsie, and Waukee soils formed. They have a thinner A horizon than Lawler, Saude, and Waukee soils, and they are better drained than Lawler soils. They are deeper to contrasting texture than Wapsie soils, and they have a browner B horizon and are better drained than Hayfield soils.

Sattre loam, 0 to 2 percent slopes (778A).—This soil is on stream benches and in upland areas. It is commonly associated with Hayfield, Lawler, and Wapsie soils and more sloping Sattre soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of soils where the depth to coarse-textured material is less than 32 inches.

This soil is well suited to intensive row cropping if it is properly managed. It is easily tilled, and runoff is slight or none. It is somewhat droughty during years of below-normal rain. Capability unit I-1; woodland suitability group 3.

Sattre loam, 2 to 5 percent slopes (778B).—This soil is on stream benches and in upland areas. It is commonly associated with Hayfield, Wapsie, and Waukee soils and more sloping Sattre soils. This soil has a profile similar to the one described as representative for the series, but depth to coarse-textured material is slightly shallower.

Included with this soil in mapping are small areas of soils where depth to sand is less than 32 inches.

This soil is well suited to row crops if it is properly managed. It is subject to slight erosion if it is cultivated, and it is somewhat droughty during years of below-normal rain. Capability unit IIe-1; woodland suitability group 3.

Sattre loam, 5 to 9 percent slopes, moderately eroded (778C2).—This soil is on stream benches and in upland areas. It is commonly associated with Wapsie and Waukee soils and with less sloping Sattre soils. This soil is similar to the one described as representative for the series, except that erosion has removed a part of the surface layer.

Included with this soil in mapping are a few areas of soils that are steeper than this soil and need more intensive conservation practices. Also included are a few areas of soils in timber. These soils have a lighter colored, thinner surface layer and are lower in content of organic matter than this Sattre soil.

This soil is moderately suited to row crops if it is properly managed. It is somewhat droughty during years of below-normal rain. Capability unit IIIe-1; woodland suitability group 3.

Saude Series

The Saude series consists of well-drained soils that formed in 24 to 32 inches of loamy alluvial material underlain by sand and gravel. These soils are nearly level to moderately sloping on stream benches and on uplands. Native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and dark brown loam about 18 inches thick. The subsoil is brown and dark yellowish-brown, friable loam in the upper part and yellowish-brown sandy loam in the lower part. The substratum, at a depth of 35 inches, is yellowish-brown gravelly loam sand that is leached.

Saude soils have moderate to low available water capacity. These soils have moderate permeability in the medium-textured material and very rapid permeability in the coarse-textured material. They are low in available nitrogen and phosphorus and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops, but they are droughty unless rain is above normal and timely.

Representative profile of Saude loam, 0 to 2 percent slopes, in a cultivated field, 100 feet west and 170 feet south of the northeast corner of NW¼NW¼ sec. 11, T. 84 N., R. 6 W.:

Ap—0 to 7 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; neutral; clear boundary.
A12—7 to 13 inches, very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) when kneaded; weak, fine, granular structure; slightly acid; gradual boundary.
A13—13 to 18 inches, dark-brown (10YR 3/3) loam; very dark grayish-brown (10YR 3/2) ped exteriors; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.
B21—18 to 23 inches, brown (10YR 4/3) loam; discontinuous very dark grayish-brown (10YR 3/2) coatings on peds; weak, medium, subangular blocky structure; friable; medium acid; gradual boundary.
B22—23 to 30 inches, dark yellowish-brown (10YR 4/4) light loam; brown (10YR 4/3) ped exteriors; weak, coarse, subangular blocky structure; friable; medium acid; gradual boundary.
B31—30 to 35 inches, dark yellowish-brown (10YR 4/4) sandy loam that contains some gravel; weak, coarse, subangular blocky structure; very friable; medium acid; gradual boundary.
C—35 to 42 inches, yellowish-brown (10YR 2/1) gravelly loamy sand; few, medium, faint, grayish-brown (10YR 5/2) mottles; single grain; loose; very friable; medium acid.

The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2) in uneroded areas. The A horizon typically ranges from 10 to 15 inches in thickness but is as much as 20 inches thick in places. It typically is loam but ranges to sandy loam. The B horizon typically has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. Clay content of the

B horizon ranges from 12 to 20 percent. The B horizon typically is medium acid but ranges from slightly acid to strongly acid. The C horizon is medium or coarse loamy sand and sand that contains some gravel. Depth to loamy sand, gravelly sand, and sand is commonly 24 to 32 inches but ranges from about 18 to 36 inches. The coarse-textured material is acid, and carbonates are leached to a depth of 6 feet or more. The content of gravel in the C horizon ranges from 5 to 15 percent.

Saude soils formed in material similar to that in which Flagler, Lawler, Wapsie, and Waukee soils formed. They are shallower to sand and gravel than Waukee soils and have a thicker, darker colored A horizon than Wapsie soils. They are better drained and have a browner B horizon than Lawler soils. They are finer textured in the upper part of the solum than Flagler soils.

Saude loam, 0 to 2 percent slopes (177A).—This soil is on stream benches and on uplands. It is associated with Lawler, Marshan, and Waukee soils on stream benches. This soil has the profile described as representative for the series.

Included with this soil in mapping are some areas of sand and gravel that are droughty and need additional plant residue to conserve moisture. These areas are indicated on the soil map by special symbols.

This soil is moderately suited to row crops. It is droughty in years of average or below-average rain. Good production of crops can be obtained if rain is timely and above normal. Capability units IIs-1; woodland suitability group 3.

Saude loam, 2 to 5 percent slopes (177B).—This soil is on stream benches and on uplands. It is associated with Lawler and Waukee soils on stream benches. The profile of this soil is similar to the one described as representative for the series, but depth to coarse-textured material is slightly less.

Included with this soil in mapping are small areas of soils where the surface layer contains more silt than that of this Saude soil. Also included are small areas of sand and gravel. These areas are droughty and need additional plant residue to conserve moisture. These areas are indicated on the soil map by special symbols.

This soil is moderately suited to row crops. It is droughty in years of normal or below-normal rain. Good production of crops can be obtained if rain is timely and above normal. This soil is subject to erosion if it is cultivated. Capability unit IIe-2; woodland suitability group 3.

Saude loam, 5 to 9 percent slopes (177C).—This soil is on stream benches and in upland areas. It is commonly associated with Lawler and Waukee soils and less sloping Saude soils on stream benches. The surface layer is 10 to 12 inches thick. Depth to sand and gravel is about 24 to 32 inches.

Included with this soil in mapping are a few areas of moderately eroded soils where the surface layer is thinner and lower in content of organic matter than that of this Saude soil. Also included are small areas of sand and gravel that are droughty and need additional plant residue to conserve moisture. These areas are indicated on the soil map by spot symbols.

This soil is moderately suited to row crops if it is properly managed. It is droughty in years of below-normal rain, and it is subject to erosion if it is cultivated. Capability unit IIIe-3; woodland suitability group 3.

Schley Series

The Schley series consists of somewhat poorly drained soils that formed in stratified loamy material and underlying glacial till at a depth of 30 to 50 inches. These soils are gently sloping and are at concave heads of upland drainageways or on side slopes along drainageways. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is dark grayish-brown, friable loam that extends to a depth of 18 inches. Mottles are in the lower 6 inches. The subsoil is grayish-brown and yellowish-brown, mottled, friable loam and sandy loam that extends to a depth of 48 inches. The substratum is mottled yellowish-brown and light brownish-gray, firm loam glacial till.

Schley soils have high available water capacity. These soils have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. They are low in available nitrogen and very low in available phosphorus and potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops if they are drained.

Representative profile of Schley loam, 1 to 4 percent slopes, in a cultivated field, 700 feet south and 200 feet east of the northwest corner of NW¼ sec. 5, T. 83 N., R. 7 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) loam; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A21—7 to 12 inches, dark grayish-brown (10YR 4/2) loam; weak, thin, platy structure and weak, fine, granular structure; friable; neutral; clear boundary.

A22—12 to 18 inches, dark grayish-brown (10YR 4/2) heavy loam; few, fine, distinct, yellowish-brown (10YR 5/4) and dark-brown (7.5YR 4/4) mottles; weak, medium, platy structure breaking to weak, fine, subangular blocky structure; friable; very strongly acid; clear boundary.

B21—18 to 23 inches, grayish-brown (2.5Y 5/2) heavy loam; common, fine, distinct, yellowish-brown (10YR 5/4 mottles; weak, fine and medium, subangular blocky structure; friable; many pores; fine, distinct, black oxide concretions; very strongly acid; clear boundary.

B22t—23 to 45 inches, grayish-brown (2.5Y 5/2) heavy sandy loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, subangular blocky structure; friable; discontinuous clay films in pores and root channels; strongly acid; clear boundary.

B3—45 to 48 inches, yellowish-brown (10YR 5/4) sandy loam; common, fine, distinct, grayish-brown (2.5Y 5/2) mottles; weak, coarse, subangular blocky structure; friable; slightly acid; clear boundary.

IIC—48 to 55 inches, mottled yellowish-brown (10YR 5/6) and light brownish-gray (2.5Y 6/2) loam; massive, breaking along vertical cleavage lines; firm; neutral.

The solum commonly is about 50 inches thick but ranges to 60 inches or more in thickness. The Ap or A1 horizon typically is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2), but the A1 horizon is black (10YR 2/1) in some places. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2), but it has higher chroma mottles. It ranges from about 8 to 12 inches in thickness. The A horizon is loam or silt loam that is high in content of sand. The B horizon has a hue of 2.5Y or 10YR, a value of 4 or 5, and a chroma of 2 to 4. The B horizon ranges from loam to silt loam that is high in content of sand to heavy sandy loam. A band of pebbles commonly separates the subsoil from the underlying material, but loamy sand is present in places. The IIB3 horizon, where present, or the IIC horizon typically has mottles that have a hue of 10YR or 2.5Y, a value of 4 to 6, and a chroma of 2 to 6. The under-

lying material typically is heavy loam, light clay loam, or sandy clay loam. Reaction typically is strongly acid or very strongly acid in the most acid part of the solum.

In Linn County, Schley soils are grayer than Schley in other survey areas, and they lack the other layer in the lower part of the subsoil that is characteristic of Schley soils, but these differences do not affect their use and behavior.

Schley soils formed in material similar to that in which Aredale, Clyde, and Floyd soils formed, and they are associated with Bassett and Kenyon soils. They are similar to Oran soils in drainage. Schley soils have a thinner and lighter colored A horizon than Aredale, Clyde, Floyd, and Kenyon soils. They are better drained than Clyde soils but are more poorly drained than Aredale and Kenyon soils. Schley soils have loamy sediment that is thicker than that in Bassett and Oran soils, and they are also more poorly drained than Bassett soils.

Schley loam, 1 to 4 percent slopes (407B).—This soil is in convex to concave downslope areas on uplands. It is commonly below better drained glacial till soils, such as Bassett and Kenyon, and above Clyde soils. It also is below Dickinson and Sparta soils in some areas.

Included with this soil in mapping are areas of soils where depth to the stratified loamy material is more than 50 inches. This stratified loamy material is underlain by grayish silt, and glacial till underlies the silt. Also included are some areas of soils where the surface layer is sandy loam. These soils generally are more seepy and wetter than this Schley soil.

If this soil is properly drained, it is moderately suited to row crops. Although it can be farmed without tile drainage, production can be increased and earlier field operations are possible if such drainage is used. The major limitation is wetness, but some areas are subject to erosion. Because wetness is the result of sidehill seepage, at least in part, a drainage system that intercepts laterally moving water is more effective than other types. In areas where soil loss is a concern, a combination of terraces and tile drainage can be used. Capability unit IIw-1; woodland suitability group 7.

Seaton Series

The Seaton series consists of well-drained soils that formed in thick, medium-textured loess on uplands. These soils are strongly sloping to very steep on side slopes along major streams and on side slopes of low ridges that extend from northwest to southeast. The native vegetation was trees.

In a representative profile the surface layer is dark grayish-brown silt loam about 6 inches thick. The subsoil, which extends to a depth of about 41 inches, is brown and yellowish-brown, friable silt loam. The substratum is yellowish-brown, friable coarse silt loam.

Seaton soils have moderate permeability and high available water capacity. They contain little organic matter except in the top few inches of uncultivated areas. They are very low in available nitrogen and potassium and high in available phosphorus. They are generally acid where they have not been limed within the last 5 years.

Less sloping Seaton soils are suited to row crops. Steeper areas are better suited to pasture and woodland than to other uses.

Representative profile of Seaton silt loam, 14 to 18 percent slopes, moderately eroded, in a cultivated field, 150 feet west and 65 feet north of the southeast corner of SW¼NE¼ sec. 9, T. 85 N., R. 6 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish-gray (10YR 6/2) dry; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

B1—6 to 12 inches, brown (10YR 4/3) silt loam; weak, fine, subangular blocky structure; friable; neutral; gradual boundary.

B21—12 to 18 inches, yellowish-brown (10YR 5/4) silt loam; brown (10YR 4/3) ped exteriors; weak, fine, subangular blocky structure; friable; neutral; gradual boundary.

B22—18 to 27 inches, yellowish-brown (10YR 5/4) silt loam; weak, fine, subangular blocky structure; friable; slightly acid; gradual boundary.

B3—27 to 41 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, subangular blocky structure; friable; medium acid; gradual boundary.

C1—41 to 55 inches, yellowish-brown (10YR 5/4) coarse silt loam; massive and has vertical cleavage; friable; medium acid; gradual boundary.

C2—55 to 70 inches, yellowish-brown (10YR 5/4) coarse silt loam; few, fine, faint, strong-brown (7.5YR 5/8) mottles; massive and has vertical cleavage; friable; medium acid.

The solum ranges from 45 inches to more than 70 inches in thickness. In uncultivated areas the A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2), and it is 2 to 5 inches thick. In cultivated areas the Ap horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3 or 5/3). Where present the A2 horizon is dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), or brown (10YR 4/3 or 5/3), and it is 3 to 5 inches thick. In eroded areas the A2 horizon, in places, is wholly incorporated into the Ap horizon. The B horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. Clay content of the B2 horizon ranges from 18 to 25 percent. The C horizon is similar to the B horizon in color, but in places it contains some low-chroma mottles. Reaction is medium acid to strongly acid in the most acid part of the solum.

Seaton soils formed in material similar to that in which Fayette soils formed, and they are associated with Chelsea and Lamont soils. They contain less clay in the B horizon than Fayette soils. They contain less sand and more silt than Chelsea and Lamont soils.

Seaton silt loam, 9 to 14 percent slopes (663D).—This soil is on convex side slopes. It is above more sloping Seaton soils and commonly below less sloping Fayette soils. In some areas it is associated with Chelsea and Lamont soils. In uncultivated areas the surface layer is very dark gray and is about 4 inches thick, and the subsurface layer is dark grayish brown. In cultivated areas all of the material originally in the subsurface layer is mixed with that originally in the surface layer, and the present surface layer is dark grayish-brown silt loam that is much lighter colored when dry.

Included with this soil in mapping are areas of sand that are indicated on the soil map by a spot symbol.

This soil is moderately well suited to row crops if it is properly managed. It is subject to severe erosion if it is cultivated and if suitable erosion control practices are not used. Most of this soil is in woodland or pasture. Capability unit IIIe-2; woodland suitability group 4.

Seaton silt loam, 9 to 14 percent slopes, moderately eroded (663D2).—This soil is on convex side slopes. It is above more sloping Seaton soils and commonly is below less sloping Fayette soils. In some areas it is associated with Chelsea and Lamont soils. This soil has a profile similar to the one described as representative of the series, except that erosion has removed a part of the surface and subsurface layers. The plow layer is dark grayish brown

and some of the brown material originally in the subsoil is mixed into it. The plow layer in this soil is lower in content of organic matter than that in uneroded Seaton soils.

Included with this soil in mapping are areas of severely eroded soils where the plow layer is brown or yellowish brown. These soils are lower in fertility and in content of organic matter than this Seaton soil.

This soil is moderately well suited to row crops if it is properly managed. Capability unit IIIe-2; woodland suitability group 4.

Seaton silt loam, 14 to 18 percent slopes (663E).—This soil is on side slopes below other Seaton soils. The surface layer is very dark gray silt loam, and it is 2 to 4 inches thick. In cultivated areas the plow layer is dark grayish brown, but it is lighter colored when dry.

This soil is better suited to hay and pasture than to row crops, and it is commonly in woods or permanent pasture. It is subject to erosion if it is cultivated. It can be used for row crops when areas used for hay or pasture need reseeding. Capability unit IVe-1; woodland suitability group 4.

Seaton silt loam, 14 to 18 percent slopes, moderately eroded (663E2).—This soil is on side slopes. It is below less sloping Seaton soils and above more sloping Seaton soils. The profile of this soil is the one described as representative for the series. Erosion has removed part of the surface layer. This soil is lower in content of organic matter than uneroded Seaton soils.

Included with this soil in mapping are areas of severely eroded soils where the plow layer is brown and yellowish-brown. These soils are lower in fertility and in content of organic matter than this Seaton soil.

This soil is better suited to hay and pasture than to row crops. It can be used for row crops when areas used for hay or pasture need reseeding. Capability unit IVe-1; woodland suitability group 4.

Seaton silt loam, 18 to 30 percent slopes (663F).—This soil is on side slopes below other Seaton soils. In timbered areas the surface layer is very dark gray silt loam and is about 2 to 5 inches thick. In cultivated areas the plow layer is dark grayish brown.

Included with this soil in mapping are a few areas of soils where the surface layer is thicker and darker colored than that of this Seaton soil.

This soil is better suited to pasture, timber, and wildlife refuge than to most other uses. In many areas it is difficult to renovate pastures safely with farm machinery because of very steep slopes. Capability unit VIIe-1; woodland suitability group 5.

Seaton silt loam, 18 to 30 percent slopes, moderately eroded (663F2).—This soil is on side slopes below less sloping Seaton soils. This soil has a profile similar to the one dscribed as representative for the series except that erosion has removed part of the surface layer. The plow layer is dark grayish-brown, and some of the original brown or yellowish-brown subsoil material is mixed into it. The plow layer in this soil is lower in fertility and in content of organic matter than that in uneroded Seaton soils.

Included with this soil in mapping are some areas of severely eroded soils where the surface layer is yellowish brown, and it is lower in content of organic matter and in fertility than that of this Seaton soil.

This soil is better suited to timber, pasture, and wildlife habitat than to most other uses. Although it has been cultivated in the past, most of it is now in hay or permanent pasture. In many areas it is difficult to renovate pastures because of very steep slopes. Capability unit VIIe-1; woodland suitability group 5.

Sogn Series

The Sogn series consists of somewhat excessively drained soils that formed in 4 to 15 inches of loamy material underlain by limestone bedrock. These soils are moderately sloping on convex ridges to very steep on short side slopes on uplands or benches. The native vegetation was mixed prairie grass and some trees.

In a representative profile the surface layer is very dark brown loam about 10 inches thick. The substratum is shattered limestone underlain by hard limestone bedrock. Crevices filled with clay or clay loam are between the weathered limestone slabs.

Sogn soils have very low available water capacity and moderate permeability. They are low in available nitrogen and very low in available phosphorus and potassium. These soils are neutral, but limestone fragments are common on the surface and throughout the soil profile.

These soils are not well suited to row crops, because of the shallowness to bedrock.

Representative profile of Sogn loam, 9 to 18 percent slopes, in a west-facing convex area in a permanent pasture, 640 feet south and 200 feet west of the northeast corner of NW¼SW¼ sec. 25, T. 83 N., R. 6 W.:

A1—0 to 10 inches, very dark brown (10YR 2/2) loam; weak, fine, granular structure; friable; numerous roots; numerous limestone fragments; mildly alkaline; clear boundary.

IIR—10 inches, shattered and partly weathered limestone; clay-filled fissures between the fractured limestone; shattered rock at depth of 12 to 36 inches underlain by hard limestone bedrock.

Thickness of the solum and depth to limestone range from 4 to 15 inches. The A1 horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is 5 to 15 inches thick. The A3 horizon is present in some profiles, and it is very dark grayish brown (10YR 3/2) or dark brown (10YR 3/3). The A horizon ranges from loam or silt loam high in content of sand to heavy sandy loam or light clay loam. In some places a layer of clay or silty material 1 to 4 inches thick is between the A horizon and the limestone. Sogn soils in this county have a higher moisture relationship than is typical for the series.

Sogn soils are associated with Bertram, Dodgeville, Rockton, and Whalan soils. They are shallower to bedrock than all the associated soils.

Sogn loam, 5 to 9 percent slopes (412C).—This soil is on side slopes on uplands and in benchlike areas. It is above more sloping areas of Sogn soils or below Bertram, Dodgeville, Rockton, and Whalan soils. This soil has a profile similar to the one described as representative for the series, but bedrock typically is deeper. The surface layer is black or very dark brown loam and is about 10 to 15 inches thick.

Included with this soil in mapping are areas where bedrock is near the surface or is exposed on the surface as shattered slabs. The areas of outcrops are indicated on

the soil map by a standard bedrock symbol. Also included are small areas of soils that have slopes of less than 5 percent.

This soil is better suited to hay or pasture than to row crops. It is not well suited to row crops, because it has a very limited root zone and is droughty. Tillage operations are very difficult because of the shallow depth to bedrock and outcrops of limestone slabs on the surface. This soil is subject to erosion if it is cultivated. Some areas of this soil have been cultivated, but most are now in meadow. Capability unit IVs-1; woodland suitability group 1.

Sogn loam, 9 to 18 percent slopes (412D).—This soil is on side slopes on uplands and in benchlike areas. It is above more sloping Sogn soils and is commonly below other less sloping soils such as Rockton or Whalan. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of moderately eroded soils where limestone outcrop is nearer to the surface than in this Sogn soil, areas where the surface layer is sandy loam or silt loam, and areas where limestone is at a depth of more than 15 inches. Also included are some areas of limestone outcrops. These areas are indicated on the soil map by a special symbol.

This soil is better suited to hay, pasture, woodland, and wildlife than to row crops. It is shallow, has a limited root zone, and is droughty. It is subject to erosion if it is cultivated. Capability unit VIs-1; woodland suitability group 1.

Sogn loam, 18 to 30 percent slopes (412G).—This soil is on short, steep side slopes below less sloping Rockton, Sogn, and Whalan soils. In places it is upslope from Steep rock land. Limetone bedrock generally is at a depth of 4 to 12 inches.

Included with this soil in mapping are many areas of shattered limestone outcrop and limestone fragments. These areas are indicated on the soil map by a special symbol. Also included are small areas of soils where limestone bedrock is at a depth of more than 12 to 15 inches.

This soil is better suited to hay and pasture than to row crops. It is droughty because it has a very shallow root zone. Carrying capacity of the pasture is low. In some areas this soil is better suited to woodland or to habitat for wildlife. Capability unit VIIs-1; woodland suitability group 1.

Sparta Series

The Sparta series consists of excessively drained soils that formed in more than 50 inches of sand commonly deposited by wind, but in some place the sand was deposited by water. These soils are nearly level to moderately sloping on benches and nearly level to moderately steep on uplands. Native vegetation was prairie grasses. Areas of these soils occur throughout the county.

In a representative profile the surface layer is very dark brown and very dark grayish-brown loamy fine sand about 19 inches thick. The subsoil is dark-brown and brown loamy fine sand. The substratum, at a depth of 36 inches, is yellowish-brown fine sand. Thin, dark-brown to brown bands of iron and clay about one-fourth inch thick are interspersed throughout the substratum.

Sparta soils have very rapid permeability and very low available water capacity. These soils are very low in available nitrogen, phosphorus, and potassium. They are acid where they have not been limed within the last 3 or 4 years.

These soils are suited to row crops if they are properly managed. Production of all crops is below average, even if management is good, unless rain is above average and very timely. Sparta soils hold little moisture and are very droughty. They are subject to both soil blowing and water erosion. Use of the less sloping areas is determined by that of the adjacent soils. The steeper areas are used mainly for pasture and woodland.

Representative profile of Sparta loamy fine sand, 2 to 5 percent slopes, in a northwest-facing convex area in a cultivated field, 342 feet west and 316 feet south of the northeast corner of NE¼NW¼ sec. 1, T. 86 N., R. 7 W.:

A1—0 to 12 inches, very dark brown (10YR 2/2) loamy fine sand; weak, fine, granular structure; very friable; medium acid; gradual boundary.

A3—12 to 19 inches, very dark grayish-brown (10YR 3/2) loamy fine sand; very weak, coarse, subangular blocky structure; very friable; medium acid; gradual boundary.

B2—19 to 27 inches, dark-brown (10YR 3/3) loamy fine sand; very weak, coarse, subangular blocky structure; very friable; medium acid; gradual boundary.

B3—27 to 36 inches, brown (10YR 4/3) loamy fine sand; very weak, coarse, subangular blocky structure; very friable; medium acid; gradual boundary.

C1—36 to 44 inches, yellowish-brown (10YR 5/6) fine sand; single grain; loose; medium acid; gradual boundary.

C2 & B2t—44 to 72 inches, yellowish-brown (10YR 5/6) fine sand; single grain; loose; bands of dark-brown to brown (7.5YR 4/4) loamy fine sand enriched with iron and clay, one-fourth inch thick, at depths of 44, 48, 53, and 70 inches; medium acid.

The solum ranges from 24 inches to about 40 inches in thickness. Dark-colored material of the A horizon ranges from 15 to 24 inches in thickness. The A horizon ranges from loamy fine sand to loamy sand or fine sand. The B horizon has a hue of 10YR and ranges from 3 to 6 in value and chroma. The B horizon is fine sand, loamy sand, or loamy fine sand. Fine-textured and medium-textured sand is dominant throughout the profile. Reaction is medium acid to strongly acid in the most acid part of the solum.

Sparta soils formed in material similar to that in which Chelsea, Dickinson, and Lamont soils formed. They are associated with Flagler, and Olin soils. They are coarser textured in the upper part of the profile than Dickinson soils. They have a darker colored and thicker A horizon than Chelsea and Lamont soils. They are coarser textured throughout the profile than Olin soils, and they are not underlain by glacial till at a depth of less than 60 inches as are Olin soils. They contain more sand in the upper part of the solum and are deeper over gravel than Flagler soils.

Sparta loamy fine sand, 0 to 2 percent slopes (41A).—This soil is on uplands or on stream benches. On uplands it is adjacent to medium-textured soils and on benches it is commonly adjacent to Dickinson, Flagler, and Sande soils. In places it is underlain by coarser-textured sand and gravel at a depth below 4 feet. The surface layer is very dark brown or very dark grayish brown and is 15 to 24 inches thick.

Included with this soil in mapping are a few areas of soils where the dark-colored surface layer is more than 24 inches thick. Also included are some small areas of soils, where the surface layer is coarser textured than that of this soil or is sandy loam in places.

This soil is suited to row crops. Production generally is low, and good growth of crops depends on the amount

and timeliness of rain. This soil is excessively drained, and it is droughty. It is subject to soil blowing. Capability unit IVs-1; woodland suitability group 2.

Sparta loamy fine sand, 2 to 5 percent slopes (41B).—This soil is in convex areas on uplands that typically blend with the landscape, and it is commonly adjacent to streams. In a few places it is in dunelike areas. It also occurs on stream benches. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are some areas of sand blowouts that are very erodible and need additional plant cover to control further erosion. These areas are indicated on the soil map by a special symbol. Also included are small areas of soils where the surface layer is sandy loam and some areas where it is coarser textured and lighter colored than that of this Sparta soil. In some areas of soils on uplands, glacial till is at a depth of less than 48 inches.

This soil is not well suited to row crops, but production is greatly increased if rain is above normal and is timely. This soil is subject to slight soil blowing and water erosion. Capability unit IVs-1; woodland suitability group 2.

Sparta loamy fine sand, 5 to 9 percent slopes (41C).—This soil commonly is in areas adjacent to drainageways and in isolated areas on uplands. A few areas are on stream benches. This soil commonly is below less sloping Dickinson, Olin, and Sparta soils on uplands, and in many places it is upslope from Clyde and Floyd soils along drainageways. The surface layer is very dark brown to very dark grayish-brown and is 12 to 16 inches thick. This soil generally is free of gravel, but a few areas, especially on benches, contain gravel at a depth below 40 inches. In a few areas glacial till is at a depth of about 48 inches.

Included with this soil in mapping are some areas of blowouts that are very erodible and need additional plant cover to prevent further erosion. These areas are indicated on the soil map by a spot symbol. Also included are areas of soils where the surface layer is lighter colored and thinner than that of this Sparta soil, and also areas where the surface layer is sandy loam.

This soil is not well suited to row crops. It is excessively drained and droughty. It is subject to soil blowing and water erosion if it is cultivated. Capability unit IVs-1; woodland suitability group 2.

Sparta loamy fine sand, 9 to 18 percent slopes (41D).—This soil is on convex side slopes along major streams and drainageways, and in some places it is on narrow convex ridges. It commonly is adjacent to other less sloping Sparta soils. The surface layer is very dark brown to very dark grayish-brown and is about 12 inches thick.

Included with this soil in mapping are areas of soils where the surface layer is less than 7 inches thick. These soils are lower in content of organic matter and in fertility than this Sparta soil. Also included are a few areas of soils where the surface layer is sandy loam and areas where glacial till is at a depth of less than 48 inches. Included in some places are areas of sand blowouts that are very erodible and need additional plant cover to control further erosion. These areas are indicated on the soil map by a special symbol.

This soil is better suited to hay and pasture than to row crops. It is excessively drained and droughty. It is subject to soil blowing and water erosion, and row crops generally are not grown. Capability unit VIs-1; woodland suitability group 2.

Sparta loamy fine sand, loam substratum, 2 to 5 percent slopes (393B).—This soil is on convex slopes on uplands. It is commonly associated with Dickinson, Kenyon, and Sparta soils. It is generally above more sloping Sparta soils. Loam glacial till is at a depth of about 36 to 48 inches.

Included with this soil in mapping are small areas of soils where depth to till is as shallow as 30 inches, and areas where the dark-colored surface layer is thicker than 20 inches. Also included are a few areas of sand blowouts that are droughty and less productive than this Sparta soil. Also included are some areas of nearly level soils. These areas are indicated on the soil map by a special symbol.

This soil is not well suited to row crops. If rain is above average and timely, production is moderate. This soil is subject to soil blowing and water erosion. It is seepy at times in spring or after heavy rains. Capability unit IVs-1; woodland suitability group 2.

Sparta loamy fine sand, loam substratum, 5 to 9 percent slopes (393C).—This soil is in areas adjacent to drainageways, and it also occurs as mounds in undulating areas on uplands. It is commonly associated with Dickinson, Kenyon, and Sparta soils. This is upslope from Clyde and Floyd soils. The surface layer is very dark brown to dark brown loamy fine sand about 12 to 16 inches thick.

Included with this soil in mapping are small areas of soils where depth to till is as shallow as 30 inches. Also included are a few areas of moderately eroded soils that have a lighter colored surface layer than this soil, and they are lower in content of organic matter and in fertility. A few areas of sand spots are included, and they are indicated on the soil map by a special symbol.

This soil is not well suited to row crops. If rain is above normal and timely, production is moderate. This soil is subject to both soil blowing and water erosion. In places it is seepy in spring or after heavy rains. Capability unit IVs-1; woodland suitability group 2.

Spillville Series

The Spillville series consists of moderately well drained to somewhat poorly drained soils that formed in medium-textured loamy alluvium. These soils are nearly level on flood plains and along intermittent streams. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown loam that extends to a depth of about 53 inches. The substratum is very dark grayish-brown loam that has thin strata of loamy sand.

Spillville soils have moderate permeability and high available water capacity. These soils are low to medium in available nitrogen and very low in available phosphorus and potassium. They are commonly neutral in reaction and generally do not need lime.

These soils are well suited to row crops, but they are subject to occasional floods.

Representative profile of Spillville loam, in a level cultivated field, 100 feet north and 200 feet west of the southeast corner of NE¼NE¼ sec. 19, T. 86 N., R. 6 W.:

Ap—0 to 8 inches, black (10YR 2/1) loam; cloddy, breaking to weak, fine, granular structure; very friable; neutral; abrupt boundary.

A12—8 to 22 inches, black (10YR 2/1) loam; weak, fine, granular structure; very friable; slightly acid; gradual boundary.

A13—22 to 49 inches, black (10YR 2/1) and very dark-brown (10YR 2/2) loam; weak, fine, subangular blocky structure; friable; medium acid; gradual boundary.

A14—49 to 53 inches, very dark brown (10YR 2/2) and very dark grayish-brown (10YR 3/2) loam; weak, fine, subangular blocky structure; friable; slightly acid.

C—53 to 60 inches, very dark grayish-brown (10YR 3/2) light loam; common, fine, faint, dark yellowish-brown (10YR 4/4) mottles; thin strata of dark grayish-brown (10YR 4/2) loamy sand; massive; friable; neutral.

The solum ranges from 40 to 60 inches in thickness. The A horizon typically is black (10YR 2/1) or very dark brown (10YR 2/2), but in some places it is very dark grayish brown (10YR 3/2) or very dark gray (10YR 3/1) in the lower part. These colors extend to a depth of 40 inches or more. The A horizon typically is loam, but in places it is silt loam that is high in content of sand. Below the A horizon in places is either a B or C horizon that commonly has a hue of 10YR, but in some places it has a hue of 2.5Y. Value is 3 or 4, and chroma is 1 or 2. The B or C horizon is commonly loam, but sandy loam containing strata of loamy sand is at a depth below 40 inches in places. Reaction of the solum is commonly neutral or slightly acid.

Spillville soils are associated with Colo, Kennebec, Lawson, and Nodaway soils. They are better drained and contain less clay and more sand than Colo soils. They contain more sand and less silt than Kennebec and Lawson soils. They are darker colored, contain more sand, and are less stratified than Nodaway soils.

Spillville loam (0 to 2 percent slopes) (485).—This soil is on bottom lands of major rivers and narrow intermittent streams. It commonly is adjacent to Colo, Kennebec, and Nodaway soils or to Loamy alluvial land.

Included with this soil in mapping are small areas of soils that are more sandy than this Spillville soil and small areas of soils that have light-colored overwash that is 6 to 20 inches thick. Also included are some sandy areas and wet spots, which are indicated on the soil map by special symbols. The sandy areas are less productive than this soil, and the wet spots need additional drainage in places.

If this soil is well managed it can be used intensively for row crops. It is subject to occasional floods during periods of heavy rain, and crop production is reduced in some years because of floods. This soil has a seasonal high water table during these periods. Tile drainage is needed in some of the small wet areas. Some areas of this soil are in permanent pasture or timber because they have been cut up by stream channels. Capability unit I-3; woodland suitability group 8.

Steep Rock Land

Steep rock land (25 to 60 percent slopes) (478G) is in very steep areas between stream benches or bottom lands and uplands. A thin layer of silt covers most areas, but in other places the surface layer is loam. Many outcroppings of limestone bedrock are present, and limestone fragments cover much of the surface in many areas.

This land type is better suited to trees and wildlife than to most other uses, but some areas are in permanent pasture. The carrying capacity for pasture is very low. Because slopes are steep, farm machinery cannot be used on this land type. Capability unit VIIs-1; woodland suitability group 1.

Stronghurst Series

The Stronghurst series consists of somewhat poorly drained soils that formed in loess. These soils are nearly level on upland divides. Native vegetation was trees.

In a representative profile the plow layer is dark-gray, friable silt loam about 7 inches thick. The subsurface layer is dark grayish-brown, platy, friable silt loam. The subsoil is dark grayish-brown and grayish-brown silty clay loam in the upper 12 inches and grades to brown and pale-brown silty clay loam and heavy silty loam. It extends to a depth of about 55 inches and has yellowish-brown and gray mottles.

Stronghurst soils have moderate permeability and have high available water capacity. They are very low in available nitrogen and potassium and medium in available phosphorus. They are acid where they have not been limed within the last 5 year.

These soils are well suited to row crops, but farming operations are often delayed during wet periods because of a moderately high water table.

Representative profile of Stronghurst silt loam, 0 to 2 percent slopes, in a cultivated field, in the southeast corner of SW¼NW¼ sec. 22, T. 82 N., R. 6 W.:

Ap—0 to 7 inches, dark-gray (10YR 4/1) silt loam, light gray (10YR 6/1) dry; weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—7 to 12 inches, dark grayish-brown (10YR 4/2) silt loam; weak, thin, platy structure; friable; few dark concretions; few, light-gray (10YR 7/2, dry), grainy coatings; neutral; clear boundary.

B1—12 to 16 inches, dark grayish-brown (10YR 4/2) light silty clay loam; moderate, fine, subangular blocky structure; friable; few dark oxide concretions; light-gray (10YR 7/2, dry), grainy coatings on peds; medium acid; clear boundary.

B21t—16 to 24 inches, grayish-brown (10YR 5/2) medium silty clay loam; few, fine, faint, dark yellowish-brown (10YR 4/4) mottles; moderate, fine and medium, subangular blocky structure; friable; thin discontinuous clay films; few, light-gray (10YR 7/2, dry), grainy coatings on peds; strongly acid; gradual boundary.

B22t—24 to 34 inches, brown (10YR 5/3) medium silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, subangular blocky structure; friable; few discontinuous clay films; light-gray (10YR 7/2) grainy coatings on peds; numerous dark oxide concretions, strongly acid; gradual boundary.

B23t—34 to 45 inches, brown (10YR 5/3) and pale-brown (10YR 6/3) light silty clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) and light-gray (10YR 7/2) mottles; weak, coarse, subangular blocky structure; firm; thin discontinuous clay films; numerous dark oxide concretions; medium acid; gradual boundary.

B3—45 to 55 inches, brown (10YR 5/3) and pale-brown (10YR 6/3) heavy silt loam; many, medium, distinct, yellowish-brown (10YR 5/6) and light-gray (10YR 7/2) mottles; weak, coarse, subangular blocky structure; friable; numerous dark oxide concretions; few clay-filled root channels; medium acid.

The solum ranges from 50 to 60 inches or more in thickness. In uncultivated areas the A1 horizon is very dark gray (10YR 3/1) silt loam and is 3 to 5 inches thick. The Ap-

horizon ranges from dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). The A2 horizon is dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 4 to 10 inches thick. The B2 horizon has a hue of 10YR or 2.5Y, a value of 4 to 6, and a chroma of 2 to 6. It ranges from light to medium silty clay loam and has a clay content of 30 to 35 percent. The B2 horizon is medium acid to strongly acid, and acidity decreases as depth increases. The C horizon, where present, is yellowish-brown, mottled, friable silt loam.

Stronghurst soils formed in material similar to that in which Atterberry, Fayette, and Muscatine soils formed. They have a thinner, lighter colored A horizon than Atterberry and Muscatine soils. They have a grayer B horizon and are more poorly drained than Fayette soils.

Stronghurst silt loam, 0 to 2 percent slopes (165A).—This soil is on upland divides and at the head of upland drainageways. It is commonly associated with Downs and Fayette soils.

Included with this soil in mapping are small areas of soils that have 6 to 20 inches of overwash. Also included are a few areas of soils that are gently sloping.

This soil is suited to corn and soybeans, but in some years farming operations are delayed during wet periods. Tile drainage is effective in some areas. Most areas of this soil are small, and cropping patterns are determined by those of the surrounding soils. Capability unit I–2; woodland suitability group 7.

Tama Series

The Tama series consists of well-drained soils that formed in loess more than 40 inches thick. These soils are mainly nearly level to moderately sloping in convex areas on uplands, but a few areas are on loess-covered stream benches. Native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark brown silty clay loam about 16 inches thick. The subsoil is brown and yellowish-brown, friable silty clay loam that extends to a depth of about 63 inches. The substratum is yellowish-brown, friable heavy silt loam that is leached.

Tama soils have moderate permeability and high available water capacity. These soils are low to medium in available nitrogen, medium in available phosphorus, and very low in available potassium. They are acid where they have not been limed within the last 5 years. Tama soils are moderately high in content of organic matter.

These soils are well suited to row crops. The more sloping areas are subject to moderate erosion if they are cultivated. Tama soils have good tilth and are easy to work.

Representative profile of Tama silty clay loam, 2 to 5 percent slopes, in a south-facing area in a cultivated field, 50 feet west and 50 feet south of the northeast corner of SE¼NE¼ sec. 8, T. 82 N., R. 5 W.:

Ap—0 to 9 inches, black (10YR 2/1) light silty clay loam; cloddy, breaking to weak, fine, granular structure; friable; slightly acid; clear boundary.

A3—9 to 16 inches, very dark brown (10YR 2/2) light silty clay loam; moderate, fine, granular structure; friable; slightly acid; smooth boundary.

B1—16 to 21 inches, brown (10YR 4/3) light silty clay loam; very dark grayish brown (10YR 3/2) ped exteriors; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B21t—21 to 29 inches, brown (10YR 4/3) medium silty clay loam; dark-brown (10YR 3/3) ped exteriors; moderate, fine, subangular blocky structure; friable; few, thin, discontinuous clay films; medium acid; gradual boundary.

B22t—29 to 39 inches, dark yellowish-brown (10YR 4/4) medium silty clay loam; brown (10YR 4/3) ped exteriors; few, fine, distinct, grayish-brown (10YR 5/2) mottles; moderate, medium, subangular blocky structure; friable; few discontinuous clay films; thin, light brownish-gray (10YR 6/2, dry), grainy coatings; few strong-brown (7.5YR 5/6) and dark reddish-brown (5YR 2/2) oxide concretions; medium acid; gradual boundary.

B3—39 to 63 inches, yellowish-brown (10YR 5/4) light silty clay loam; common, fine, distinct, grayish-brown (10YR 5/2) mottles; few, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, medium, prismatic structure breaking to weak, coarse, subangular blocky structure; friable; thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; few dark reddish-brown (5YR 2/2) oxide concretions; medium acid; gradual boundary.

C—63 to 83 inches, yellowish-brown (10YR 5/4) heavy silt loam; common, fine and medium, distinct, grayish-brown (10YR 5/2) and strong-brown (7.5YR 5/6) mottles; massive, breaking along vertical cleavage lines; friable; many, fine, soft, dark reddish-brown (5YR 2/2) oxide concretions; ¼-inch, yellowish-brown (10YR 5/4), horizontal bands of loamy sand at depths of 63, 65, 69, 73, and 78 inches; medium acid.

The solum ranges from about 50 to 80 inches in thickness. The A1 or Ap horizon is black (10YR 2/1) or very dark brown (10YR 2/2). The A horizon ranges from 13 to 20 inches in thickness in uneroded areas. The A horizon ranges from silt loam to silty clay loam. The B horizon typically has a hue of 10YR, a value of 3 to 5, and a chroma of 3 to 6. The B2t horizon is from 27 to 35 percent clay. Depth to grayish mottles is about 30 to 50 inches. Reaction is medium acid to strongly acid in the most acid part of the solum.

Tama soils formed in material similar to that in which Downs, Fayette, and Muscatine soils formed, and they are associated with Dinsdale soils. They have a thicker, darker colored A horizon than Downs and Fayette soils. They formed in loess more than 40 inches thick, whereas Dinsdale soils formed in loess and glacial till, and Tama soils contain less sand in the lower part of the solum than those soils. Tama soils have a browner B horizon and are better drained than Muscatine soils.

Tama silty clay loam, 0 to 2 percent slopes (120A).—This soil is on uplands. It is dominantly in the southeastern part of the county, where limestone is at a depth of 6 to 10 feet. It is associated with Atterberry and Muscatine soils and more sloping Tama soils. The surface layer is black to very dark brown, friable silty clay loam and is 12 to 20 inches thick.

This soil is well suited to intensive row cropping. Because this soil is nearly level and has a high water-infiltration rate, little or no runoff occurs. Capability unit I–1; woodland suitability group 4.

Tama silty clay loam, 2 to 5 percent slopes (120B).—This soil is on upland ridges above moderately sloping Tama soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of soils where glacial till at a shallower depth than in this soil, and those soils are lower in fertility and less permeable.

This soil can be used intensively for row crops if erosion is controlled. It is well suited to terraces because slopes are generally long and smooth. Capability unit IIe–1; woodland suitability group 4.

Tama silty clay loam, 5 to 9 percent slopes (120C).—This soil is in convex areas on uplands below less sloping Tama soils. The plow layer is very dark brown silty clay loam.

Included with this soil in mapping are small areas of soils that have a thinner, lighter colored surface layer and are lower in content of organic matter than this Tama soil.

This soil is well suited to corn and soybeans. It is friable and easy to work, but it is subject to erosion if it is cultivated. This soil is well suited to terraces because slopes are generally long and smooth and the exposed subsoil responds to management. Capability unit IIIe-1; woodland suitability group 4.

Tama silty clay loam, 5 to 9 percent slopes, moderately eroded (120C2).—This soil is on convex areas on uplands. It is commonly below these sloping Tama soils. This soil has a profile similar to the one described as representative for the series, except that erosion has removed part of the surface layer and some of the subsoil is mixed into the plow layer. At times it puddles during intense rain, resulting in more runoff and retarded plant growth. It is lower in content of organic matter and fertility than that of uneroded Tama soils, and it becomes cloddy if it is worked when wet.

This soil is suited to row crops if it is properly managed. More fertilizer will be required than on uneroded Tama soils to obtain the same production. Runoff is rapid, and further erosion is a serious hazard. Capability unit IIIe-1; woodland suitability group 4.

Tama silty clay loam, benches, 0 to 2 percent slopes (T120A).—This soil is on loess-covered benches above flood plains. On benches it is commonly associated with Atterberry, Muscatine, and Walford soils more sloping Tama soils. The surface layer is black to very dark brown, friable silty clay loam and is about 12 to 20 inches thick. In some places, coarse-textured material is at a depth of about 48 inches.

Included with this soil in mapping are small areas of soils where the surface layer is thinner and lighter colored than this soil and the content of organic matter is lower.

This soil is well suited to intensive use for corn and soybeans. In places it receives runoff and sediment from soils at higher elevations. Capability unit I-1; woodland suitability group 4.

Tama silty clay loam, benches, 2 to 5 percent slopes (T120B).—This soil is on loess-covered benches along major rivers. On benches it is commonly associated with Atterberry, Fayette, and Muscatine soils and nearly level Tama soils. The surface layer is black to very dark brown, friable silty clay loam and is about 12 to 15 inches thick. In some places coarse-textured material is at a depth of about 48 inches.

Included with this soil in mapping are small areas of soils where the surface layer is thinner and lighter colored than this soil and the content of organic matter is lower.

This soil is well suited to row crops if it is properly managed. It is subject to erosion if it is cultivated. Capability unit IIe-1; woodland suitability group 4.

Tell Series

The Tell series consists of well-drained soils that formed in silty material about 24 to 36 inches thick and in contrasting sand and loamy sand. These soils are gently sloping to moderately sloping and are on benches and on uplands. The native vegetation was trees.

In a representative profile the surface layer is dark grayish-brown silt loam about 6 inches thick. The subsoil extends to a depth of about 42 inches. It is brown and yellowish-brown silt loam and silty clay loam in the upper part and grades to yellowish-brown loam and loamy sand. The substratum is yellowish-brown, loose fine sand.

Tell soils have moderate permeability in the upper part of the profile and very rapid permeability in the lower part. They are low in content of organic matter and have moderate available water capacity. They are very low in available nitrogen and potassium and medium in available phosphorus. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops but are droughty in some years.

Representative profile of Tell silt loam, 2 to 5 percent slopes, in a cultivated field, 360 feet west and 1,100 feet south of the northeast corner of NW¼NE¼ sec. 3, T. 82 N., R. 6 W.:

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

B1—6 to 12 inches, brown (10YR 5/3) heavy silt loam; weak to moderate, fine, subangular blocky structure; friable; neutral; gradual boundary.

B21t—12 to 19 inches, yellowish-brown (10YR 5/4) silty clay loam; brown (10YR 4/3) ped exteriors; moderate, medium, subangular blocky structure; friable; thin discontinuous clay films on peds; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings on peds; slightly acid; gradual boundary.

B22t—19 to 25 inches, yellowish-brown (10YR 5/4) light silty clay loam; dark yellowish-brown (10YR 4/4) ped exteriors; moderate, medium, prismatic structure breaking to moderate, medium, subangular blocky structure; thin discontinuous clay films on peds; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings on peds; slightly acid; gradual boundary.

I&IIB3t—25 to 32 inches, yellowish-brown (10YR 5/4) loam; weak, coarse, prismatic structure breaking to weak, fine, subangular blocky structure; friable; thin discontinuous clay films and light-gray (10YR 7/2, dry) grainy coatings on peds; medium acid; gradual boundary.

IIB32—32 to 42 inches, yellowish-brown (10YR 5/4) loamy sand; weak, coarse, subangular blocky structure; very friable; slightly acid; clear boundary.

IIC—42 to 72 inches, yellowish-brown (10YR 5/6) fine sand; single grain; loose; 1-inch bands of dark-brown to brown (7.5 4/4) sandy loam interspersed throughout horizon; neutral.

The solum ranges from about 24 to 45 inches in thickness and in places corresponds with the depth to loamy sand or sand. Depth to sandy material or contrasting textures is 24 to 40 inches. The Ap horizon is dark grayish-brown (10YR 4/2) or brown (10YR 4/3). Where present, the A2 horizon has a value of 4 or 5 and a chroma of 2 or 3, and in eroded areas it is wholly incorporated into the Ap horizon in places. The B2 horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. It is heavy silt loam to medium silty clay loam. The IIB3 horizon is similar to the B2 horizon in color, but it is loam, sandy loam, sandy clay loam, or loamy sand. The IIC horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 3 to 8. It is sand or loamy sand. Reaction is medium acid to very strongly acid in the most acid part of the solum.

Tell soils formed in material similar to that in which Atterberry, sandy substratum, Fayette, Waukegan, and Whittier soils formed. They are underlain by sand at a depth of 2 to 3 feet, and Fayette soils are not underlain by sand. They have a thinner A horizon than Waukegan and Whittier soils. They have a browner B horizon and are better drained than Atterberry soils, sandy substratum.

Tell silt loam, 2 to 5 percent slopes (353B).—This soil is on stream benches and on uplands. It is commonly associated with Atterberry soils, sandy substratum; Fayette, Lamont, and Whittier soils; and more sloping Tell soils. The profile of this soil is the one described as representative for the series. Sand generally is at a depth of 36 to 40 inches.

Included with this soil in mapping are small areas of soils where sand is at a depth of 24 to 36 inches. These areas are droughty during some years of normal rain unless rain is timely. Also included are small areas of nearly level soils that are not subject to erosion.

This soil is suited to row crops if it is well managed. It is subject to erosion if it is cultivated. Capability unit IIe-1; woodland suitability group 3.

Tell silt loam, 5 to 9 percent slopes, moderately eroded (353C2).—This soil is on convex side slopes on uplands and on stream benches. It is commonly associated with Atterberry soils, sandy substratum; Lamont and Whittier soils; and less sloping Tell soils. The profile of this soil is similar to the one described as representative of the series, except that erosion has removed part of the surface and subsurface layers. In cultivated areas the plow layer is dark grayish brown and some of the original brown and dark yellowish-brown subsoil is mixed into it. This plow layer is low in content of organic matter and in fertility. It becomes cloddy if it is worked when wet. In places this soil puddles during intense rains, resulting in increased runoff and retarded plant growth. The depth to sand typically is about 30 inches, but there are small areas where the depth to coarse-textured material is 24 inches.

This soil is suited to row crops if it is well managed. It is droughty during some years of below-normal rainfall unless rain is timely. It is subject to further erosion if it is cultivated. Terrace cuts should be minimized to avoid exposing the sandy substratum. Capability unit IIIe-1; woodland suitability group 3.

Tripoli Series

The Tripoli series consists of poorly drained soils that formed in 18 to 24 inches of loamy material and underlying glacial till. In most places a layer of pebbles and stones is between the loamy material and the glacial till. These soils are nearly level and are on slightly concave upland flats or at the head of drainageways. The native vegetation was mixed prairie grasses and water-tolerant plants.

In a representative profile the surface layer is black and very dark gray, gritty silty clay loam and light clay loam about 18 inches thick. The upper 9 inches of the subsoil is grayish-brown and dark-gray, friable light clay loam. A band of pebbles is at a depth of 22 inches. The lower part of the subsoil is grayish-brown, gray, and light brownish-gray, firm loam that has yellowish-brown mottles. The substratum, at a depth of 44 inches, is light brownish-gray sandy clay loam and yellowish-brown, firm loam.

Tripoli soils have high available water capacity. Permeability is moderate in the upper part of the profile and moderately slow in the lower part. These soils are medium in available nitrogen and very low in available phosphorus and potassium. They are neutral to mildly alkaline.

These soils are well suited to intensive use for row crops if they are drained.

Representative profile of Tripoli silty clay loam, in a cultivated field, 460 feet south and 100 feet west of the northeast corner of NW¼NW¼ sec. 13, T. 85 N., R. 8 W.:

Ap—0 to 8 inches, black (N 2/0) gritty silty clay loam; cloddy, breaking to moderate, fine, granular structure; friable; neutral; abrupt boundary.

A12—8 to 14 inches, black (N 2/0) gritty silty clay loam; weak, fine, subangular blocky structure breaking to weak, fine, granular structure; friable; neutral; clear boundary.

A3g—14 to 18 inches, very dark gray (10YR 3/1) light clay loam; few, fine, distinct, very dark grayish-brown (2.5Y 3/2) mottles; weak, medium, subangular blocky structure breaking to weak, fine, granular structure; friable; neutral; clear boundary.

B1g—18 to 22 inches, grayish-brown (2.5Y 5/2) light clay loam; few, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; neutral; clear boundary.

IIB21g—22 to 27 inches, dark-gray (5Y 4/1) and grayish-brown (2.5Y 5/2) light clay loam; few, fine to medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, subangular blocky structure; friable; band of pebbles at a depth of 22 to 23 inches; neutral; gradual boundary.

IIB22g—27 to 38 inches, grayish-brown (2.5Y 5/2) and gray (5Y 5/1) heavy loam; common, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, medium, prismatic structure breaking to weak, medium, subangular blocky structure; firm; neutral; gradual boundary.

IIB31—38 to 44 inches, light brownish-gray (2.5Y 6/2) heavy loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure breaking to weak, medium, prismatic structure; firm; light-gray (10YR 7/1) sand lens on horizontal cleavage planes; neutral; gradual boundary.

IIC1—44 to 59 inches, light brownish-gray (2.5Y 6/2) sandy clay loam; many, medium, distinct, yellowish-brown (10YR 5/6) mottles; massive; few vertical cleavage planes; firm; neutral; gradual boundary.

IIC2—59 to 64 inches, yellowish-brown (10YR 5/6) heavy loam; massive; firm; moderately alkaline.

The solum ranges from about 40 to 50 inches in thickness. The loamy material is 18 to 24 inches thick over the underlying glacial till. The A horizon is black (N 2/0 or 10YR 2/1) in the upper part and very dark gray (10YR 3/1 or 5Y 3/1) in the lower part. The A horizon is 15 to 22 inches thick and ranges from silty clay loam that is high in content of sand to light and medium clay loam. The IIB2 horizon has a hue of 2.5Y or 5Y, a value of 4 to 6, and a chroma of 1 or 2, but mottles are higher in chroma. The IIB and IIC horizons are commonly heavy loam but range to light clay loam and sandy clay loam. Carbonates are typically at a depth of less than 60 inches. Reaction is neutral to slightly acid in the A horizon and neutral to mildly alkaline in the B horizon.

Tripoli soils formed in material similar to that in which Kenyon, Readlyn, and Oran soils formed, and they are associated with Clyde and Floyd soils. They are more poorly drained and have a grayer B horizon than Floyd, Kenyon, Oran, and Readlyn soils. They are shallower to glacial till and to carbonates than Clyde soils.

Tripoli silty clay loam (0 to 2 percent slopes) (398).—This soil is on slightly concave upland flats and at the end of upland drainageways. It commonly adjoins Kenyon, Oran, and Readlyn soils. Clyde and Floyd soils typically are below Tripoli soils in the drainageways.

This soil is well suited to intensive use for corn and soybeans. It generally has good tilth but puddles if it is worked when wet. Wetness is the major limitation, and production generally is not very good unless tile drainage

is used. Suitable drainage outlets generally are available. Capability unit IIw-1; woodland suitability group 9.

Walford Series

The Walford series consists of poorly drained soils that formed in loess more than 40 inches thick. The soils are in flat or depressional areas on uplands or on stream benches. Native vegetation was prairie grasses and trees.

In a representative profile the plow layer is very dark gray silt loam about 7 inches thick. The subsurface layer, to a depth of about 20 inches, is dark grayish-brown and grayish-brown, friable silt loam. It is platy and is lighter colored when dry. The subsoil, to a depth of 65 inches, is grayish-brown, friable heavy silt loam in the upper 6 inches and grayish-brown, light brownish-gray, and yellowish-brown, firm silty clay loam in the lower part. It has yellowish-brown and strong-brown mottles.

Walford soils have slow permeability and high available water capacity. They are low in available nitrogen and phosphorus and very low in available potassium. These soils are acid where they have not been limed within the last 5 years.

These soils are suited to row crops if they are artificially drained. In places the areas are ponded because of runoff received from adjacent soils. Tile and surface drains can be used to remove excess water.

Representative profile of Walford silt loam, benches, in a cultivated field, 485 feet west and 150 feet north of the southeast corner of NW1/4SW1/4 sec. 26, T. 82 N., R. 5 W.:

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; cloddy, breaking to weak, fine, granular structure; friable; slightly acid; clear boundary.

A21—7 to 13 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, platy structure breaking to weak, fine, granular structure; friable; medium acid; clear boundary.

A22—13 to 20 inches, dark grayish-brown (10YR 4/2) and grayish-brown (2.5Y 5/2) silt loam; light gray (10YR 7/2) dry; few, fine, faint, yellowish-brown (10YR 5/4) mottles; weak, thin, platy structure; friable; few dark-brown oxide concretions; medium acid; clear boundary.

B21t—20 to 26 inches, grayish-brown (2.5Y 5/2) heavy silt loam; common, fine, distinct, yellowish-brown (10YR 5/4) mottles; weak, fine, subangular blocky structure; friable; discontinuous very dark gray (10YR 3/1) clay films; common very dark brown (10YR 2/2) oxide concretions; medium acid; clear boundary.

B22t—26 to 32 inches, grayish-brown (2.5Y 5/2) light silty clay loam; many, fine, distinct, strong-brown (7.5YR 5/6) mottles; weak, coarse, prismatic structure breaking to moderate, fine, subangular blocky structure; firm; continuous black (10YR 2/1) clay films; common black (10YR 2/1) oxide concretions; medium acid; gradual boundary.

B23t—32 to 56 inches, grayish-brown (2.5Y 5/2) medium silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles; weak, coarse, prismatic structure; firm; continuous black (10YR 2/1) oxide concretions; slightly acid; gradual boundary.

B31t—56 to 65 inches, mottled light brownish-gray (2.5Y 6/2) and yellowish-brown (10YR 5/6) light silty clay loam; weak, coarse, prismatic structure; firm; discontinuous black (10YR 2/1) clay films on peds and in root channels; slightly acid.

The solum ranges from 50 to 70 inches in thickness. The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick. The A2 horizon has a hue of 10YR or 2.5Y, a value of 4 to 6, and a chroma of 1 or 2. It ranges from 8 to 14 inches in thickness. The B2t horizon has a hue of 10YR or 2.5Y, a value of 4 to 6, and a chroma of 1 or 2, but mottles are higher in chroma. Clay content of the Bt horizon ranges from 32 to 38 percent, but the weighted clay average is less than 35 percent. Reaction is medium acid to strongly acid in the most acid part of the B horizon.

Walford soils formed in material similar to that in which Atterberry, Garwin, Muscatine, and Tama soils formed. They have a thicker, more prominent A2 horizon than Atterberry soils and are more poorly drained than Atterberry, Muscatine, and Tama soils. They have a thinner, lighter colored A horizon than Garwin soils.

Walford silt loam (0 to 2 percent slopes) (160).—This soil is in depressional areas on uplands. It is adjacent to Atterberry, Downs, and Tama soils.

Included with this soil in mapping are areas of soils where the surface layer is thicker and darker colored than that of this soil, and the upper part of the subsoil is darker colored and more clayey than that of this soil. Also included are small areas of soils where glacial till is at a depth of about 36 inches. Some of these areas have a thinner, lighter colored surface layer than this soil, and they contain more clay in the subsoil. Some areas of soils that have 6 to 20 inches of light-colored overwash are also included.

If drained, this soil is suited to intensive use for row crops. Some areas are ponded for short periods, and in some years crops are destroyed. Drainage by tile or open ditches is needed. Most areas of this soil are small and are farmed along with the surrounding soils. Capability unit IIw-2; woodland suitability group 9.

Walford silt loam, benches (0 to 2 percent slopes) (T160).—This soil is in flat or depressional areas on loess-covered benches along major streams. It is adjacent to Atterberry, Tama, and Waukegan soils on benches. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are areas of soils where the surface layer is thicker and darker colored than that of this soil and the upper part of the subsoil is darker colored and more clayey than that of this soil. Also included are areas of soils where coarse-textured material is at a depth of 48 to 72 inches, areas of soils where sandy material is as shallow as 40 inches, and areas of soils that have 6 to 20 inches of light-colored overwash.

If this soil is drained, it can be used frequently for row crops. Because it is in low areas, it receives runoff from surrounding soils, and some areas are ponded for short periods. Drainage by tile or open ditches is needed. Field operations commonly are delayed because of wetness. Most areas of this soil are small and are farmed along with surrounding soils. Capability unit IIw-2; woodland suitability group 9.

Wapsie Series

The Wapsie series consists of well-drained soils that formed in 24 to 32 inches of loamy material underlain by coarse sand and gravel. These soils are nearly level to gently sloping and are on stream benches and on uplands. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark brown, friable loam about 8 inches thick. The subsurface layer is dark grayish-brown, friable loam about 3 inches thick. The subsoil is brown to dark yellowish-brown, fri-

able loam and sandy loam. The substratum, at a depth of 28 inches, is yellowish-brown fine and medium sand containing thin strata of strong-brown loamy fine sand.

Wapsie soils are moderately permeable in the upper part of the profile and very rapidly permeable in the coarse-textured substratum. They have low to moderate available water capacity. They are low in available nitrogen and phosphorus and very low in available potassium. These soils are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops, but they are droughty in years of average or below-average rain.

Representative profile of Wapsie loam, 2 to 5 percent slopes, in a permanent pasture, 545 feet north and 325 feet west of the southeast corner of NE¼SW¼ sec. 30, T. 84 N., R. 6 W.:

A1—0 to 8 inches, very dark brown (10YR 2/2) loam, grayish brown (10YR 5/2) dry; weak, subangular blocky structure; friable; medium acid; clear boundary.

A2—8 to 11 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) dry; weak, medium, platy structure breaking to weak, fine, subangular blocky structure; friable; nearly continuous, light-gray (10YR 7/2, dry), grainy coatings; medium acid; clear boundary.

B1—11 to 15 inches, brown (10YR 4/3) loam, weak, fine, subangular blocky structure; friable; nearly continuous, light-gray (10YR 7/2, dry), grainy coatings; medium acid; gradual boundary.

B2t—15 to 23 inches, dark yellowish-brown (10YR 4/4) loam; weak, medium, subangular blocky structure; friable; thin, discontinuous, dark yellowish-brown (10YR 3/4) clay films; discontinuous, light-gray (10YR 7/2, dry), grainy coatings; medium acid; gradual boundary.

B31t—23 to 28 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, coarse, subangular blocky structure; few, discontinuous, dark yellowish-brown (10YR 3/4) clay films; strongly acid; clear boundary.

IIC1—28 to 40 inches, yellowish-brown (10YR 5/4) fine and medium sand; very weak, coarse, subangular blocky structure breaking to single grained; very friable; strongly acid; gradual boundary.

IIC2—40 to 60 inches, yellowish-brown (10YR 5/6) fine and medium sand; very weak, coarse, subangular blocky structure breaking to single grained; very friable; a strong-brown band of loamy fine sand is at a depth of 52 to 56 inches; strongly acid.

The solum typically ranges from 24 to 40 inches in thickness, and in places this thickness corresponds with the depth to contrasting texture of loamy sand or sand. Depth to these materials ranges from 24 to 32 inches. The A1 or Ap horizon is very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is 6 to 10 inches thick. The A2 horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 2 or 3. The A2 horizon is wholly incorporated into the Ap horizon in some eroded or cultivated areas. The A horizon is loam or silt loam that is high in content of sand. The B2 horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 8. The B horizon is loam or light sandy clay loam that grades to sandy loam or loamy sand in the lower part. Clay content of the B horizon ranges from about 15 to 20 percent. The C horizon has a hue of 10YR or 7.5YR, a value of 5 or 6, and a chroma of 4 to 8. The C horizon is loamy sand or sand that contains some gravel in places. Reaction is medium acid to strongly acid in the most acid part of the solum.

Waspie soils formed in material similar to that in which Hayfield, Sattre, Saude, and Waukee soils formed. They are shallower to sand and gravel than Sattre and Waukee soils. They are browner in the upper part of the B horizon and are better drained than Hayfield soils.

Wapsie loam, 0 to 2 percent slopes (777A).—This soil is on stream benches or in outwash areas on uplands. It is commonly associated with Hayfield and Sattre soils. This soil has a profile similar to the one described as representative for the series, but loamy textured material generally is about 30 inches thick.

Included with this soil in mapping are small areas of soils where depth to coarse-textured material is less than 24 inches. Also included are a few areas of soils where the surface layer is thinner, lighter colored, and lower in content of organic matter than that of this Wapsie soil.

This soil is suited to row crops, but it is droughty in most years unless rain is above average or timely. Capability unit IIs-1; woodland suitability group 3.

Wapsie loam, 2 to 5 percent slopes (777B).—This soil is on stream benches or in outwash areas on uplands. It is commonly associated with less sloping Wapsie soils and with Hayfield, Sattre, and Waukee soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are a few areas of soils that formed under timber. These areas are lower in content of organic matter than this Wapsie soil. Also included are some areas of steeper soils that are more susceptible to erosion.

This soil is suited to row crops, but it is droughty in most years unless rain is above normal or timely. Capability unit IIe-2; woodland suitability group 3.

Waubeek Series

The Waubeek series consists of moderately well drained and well drained soils that formed in 24 to 40 inches of loess and underlying glacial till. These soils are gently sloping to moderately sloping and are in convex areas on uplands. The native vegetation was trees and prairie grasses.

In a representative profile the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsurface layer is dark grayish-brown silt loam about 3 inches thick. The subsoil is dark yellowish-brown and yellowish-brown silty clay loam to a depth of about 26 inches. The lower 32 inches is yellowish-brown, mottled, firm sandy clay loam and heavy loam. The substratum, at a depth of 58 inches, is yellowish-brown, mottled, firm heavy loam that is mildly alkaline.

Waubeek soils have high available water capacity. They have moderate permeability in the upper part of the profile and moderately slow permeability in the lower part. They are low in available nitrogen and phosphorus and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are well suited to row crops.

Representative profile of Waubeek silt loam, 2 to 5 percent slopes, in a cultivated field, 150 feet east and 600 feet north of the southwest corner of NW¼NE¼ sec. 19, T. 83 N., R. 5 W.:

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—7 to 10 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak, thin to medium, platy structure to weak, fine, subangular blocky structure; friable; neutral abrupt boundary.

B1t—10 to 17 inches, dark yellowish-brown (10YR 4/4) light silty clay loam; brown (10YR 4/3) ped exteriors; mod-

erate, fine, subangular blocky structure; friable; few, thin, discontinuous, dark-brown to brown (7.5YR 4/4) clay films on peds; few, thin, discontinuous, light-gray (10YR 7/2, dry) coatings on peds; slightly acid; gradual boundary.

B21t—17 to 22 inches, yellowish-brown (10YR 5/6) medium silty clay loam; dark yellowish-brown (10YR 4/4) ped exteriors; thin, discontinuous, dark-brown to brown (7.5YR 4/4) clay films on peds; thin, discontinuous, light-gray (10YR 7/2, dry) coatings on peds; strongly acid; gradual boundary.

B22t—22 to 26 inches, yellowish-brown (10YR 5/4) light silty clay loam; dark yellowish-brown (10YR 4/4) ped exteriors; moderate, fine to medium, subangular blocky structure; friable; thin, discontinuous, dark-brown to brown (7.5YR 4/4) clay films on peds; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings on peds; few brown (7.5YR 5/4) oxide concretions; strongly acid; clear boundary.

IIB23t—26 to 35 inches, yellowish-brown (10YR 5/4) sandy clay loam; few, fine, distinct, strong-brown (7.5YR 5/8) and light brownish-gray (10YR 6/2) mottles; weak, coarse, prismatic structure breaking to weak, medium, subangular blocky structure; firm discontinuous band of pebbles at a depth of 26 to 27 inches; dark-brown (7.5YR 3/2) clay films on peds; thin, discontinuous, light-gray (10YR 7/2, dry) coatings on peds; numerous dark-brown oxide concretions; strongly acid; gradual boundary.

IIB3t—35 to 58 inches, yellowish-brown (10YR 5/4) heavy loam; common, medium, faint, light brownish-gray (10YR 6/2) mottles; weak, coarse, prismatic structure; firm; discontinuous dark-brown (7.5YR 3/2) clay films on peds; many dark-brown oxide concretions; slightly acid; gradual boundary.

IIC—58 to 72 inches, yellowish-brown (10YR 5/4) heavy loam; common, medium, distinct, light brownish-gray (10YR 6/2) mottles; massive; firm; few dark-brown oxide concretions; mildly alkaline.

The solum typically is more than 50 inches thick, but it ranges from 42 to about 60 inches in thickness. The loess commonly is 24 to 40 inches thick, but it ranges from 20 to 40 inches in thickness. The A1 or Ap horizon is very dark brown (10YR 2/2), very dark grayish brown (10YR 3/2), or very dark gray (10YR 3/1). It is 6 to 10 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3 or 5/3). In some cultivated or eroded areas, the A2 horizon is wholly incorporated into the Ap horizon. The upper part of the B horizon ranges from light to medium silty clay loam. It has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. The lower part of the B horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 4 to 8, and it has few to common, low-chroma mottles. The lower part of the B horizon ranges from loam or sandy clay loam to light clay loam. Lenses of sandy loam or loamy sand as much as 10 inches thick are between the loess and the glacial till in places. Reaction is medium acid to strongly acid in the most acid part of the solum.

Waubeek soils formed in material similar to that in which Dinsdale, Franklin, Klinger, and Maxfield soils formed, and they are associated with Bassett soils. They have a thinner dark horizon than Dinsdale, Klinger, and Maxfield soils. They have a browner B horizon and are better drained than Franklin, Klinger, and Maxfield soils. They contain less sand and more silt in the upper part of the solum than Bassett soils.

Waubeek silt loam, 2 to 5 percent slopes (771B).—This soil is in convex areas on uplands. It is commonly associated with Franklin soils and more sloping Waubeek soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are small areas of soils where the surface layer contains more sand than that of this Waubeek soil.

This soil is well suited to row crops, but it is subject to erosion. Terrace cuts should be minimized to avoid exposing the glacial subsoil that is lower in fertility. Capability unit IIe-1; woodland suitability group 4.

Waubeek silt loam, 5 to 9 percent slopes, moderately eroded (771C2).—This soil is on convex ridges on uplands. It is associated with Bassett soils and less sloping Waubeek soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is browner, all the material in the subsurface layer and some of the material in the subsoil are incorporated into the plow layer. This soil is lower in content of organic matter than uneroded Waubeek soils.

This soil is moderately well suited to row crops, but if it is cultivated, it is subject to further erosion. Terrace cuts should be minimized to avoid exposing the glacial subsoil that is lower in fertility. Capability unit IIIe-1; woodland suitability group 4.

Waukee Series

The Waukee series consists of well-drained soils that formed in loamy alluvium and are underlain by sand or gravel at a depth of 32 to 40 inches. These soils are nearly level to moderately sloping on stream benches and on uplands. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark brown and black loam about 23 inches thick. The subsoil is brown loam to loamy sand in the upper 8 inches and dark yellowish-brown fine sandy loam in the next 17 inches. The substratum, at a depth of 48 inches, is brown sand that contains some gravel.

Waukee soils have moderate permeability in the medium-textured material and rapid to very rapid permeability in the coarser textured material. They have moderate available water capacity. These soils are low to medium in available nitrogen, low in available phosphorus, and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops, but they tend to be somewhat droughty during years of below-normal rain.

Representative profile of Waukee loam, 0 to 2 percent slopes, in a cultivated field, 860 feet east and 80 feet north of the southwest corner of SW¼NW¼ sec. 16, T. 84 N., R. 8 W.:

Ap—0 to 6 inches, very dark brown (10YR 2/2) loam; cloddy, breaking to weak, fine, granular structure; friable; slightly acid; abrupt boundary.

A12—6 to 13 inches, black (10YR 2/1) loam; moderate, fine, granular structure; friable; slightly acid; gradual boundary.

A13—13 to 18 inches, very dark brown (10YR 2/2) loam; weak, very fine, subangular blocky structure; friable; slightly acid; gradual boundary.

A3—18 to 23 inches, very dark brown (10YR 2/2) loam; weak, medium, subangular blocky structure; friable; slightly acid; gradual boundary.

B21—23 to 31 inches, brown (10YR 4/3) loam; dark-brown (10YR 3/3) ped exteriors; weak, medium, subangular blocky structure; friable; slightly acid; gradual boundary.

B22—31 to 38 inches, dark yellowish-brown (10YR 4/4) heavy fine sandy loam; weak, coarse, subangular blocky structure; friable; medium acid; gradual boundary.

B3—38 to 48 inches, dark yellowish-brown (10YR 4/4) loamy sand; weak, coarse, subangular blocky structure; very friable; slightly acid; gradual boundary.

C—48 to 55 inches, brown (10YR 5/3) medium sand that contains some gravel; single grain; loose; slightly acid.

Thickness of the solum in places corresponds to the depth to coarse loamy sand or gravelly sand. Depth to sandy and gravelly material typically is 32 to 40 inches. The A1 or Ap

horizon is black (10YR 2/1) or very dark brown (10YR 2/2). It is loam or silt loam that is high in content of sand. The A horizon ranges from 13 to 23 inches in thickness. The B2 horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. The B2 horizon is loam, sandy clay loam, or heavy sandy loam. Clay content of the B2 horizon ranges from about 18 to 24 percent. The C horizon is coarse loamy sand, gravelly sand, or medium sand. Gravel content is about 10 to 20 percent, but in places it ranges to as much as 20 to 50 percent. Reaction is medium acid to strongly acid in the most acid part of the solum.

The Waukee soils formed in material similar to that in which Lawler, Marshan, Sattre, Saude, and Wapsie soils formed. They are deeper to coarse-textured material than Saude and Wapsie soils and they have a thicker, darker colored A horizon than Sattre and Wapsie soils. Waukee soils have a browner B horizon and are better drained than Lawler and Marshan soils.

Waukee loam, 0 to 2 percent slopes (178A).—This soil is on stream benches and in outwash areas. It is commonly associated with Lawler and Saude soils and more sloping Waukee soils. The profile of this soil is the one described as representative for the series.

Included with this soil in mapping are a few areas of soils where depth to coarse-textured material is less than 32 inches and a few areas where depth is more than 40 inches. Also included are small areas of sand and gravel outcrops that are droughty and less productive than this Waukee soil. These areas are indicated on the soil map by special symbols.

This soil is well suited to intensive use for row crops. It is easily tilled, and runoff is slow. It is somewhat droughty during some years of below-normal rain. Capability unit I–1; woodland suitability group 3.

Waukee loam, 2 to 5 percent slopes (178B).—This soil is on stream benches and in outwash areas. It is commonly associated with Lawler and Saude soils and more sloping Waukee soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is not so thick.

Included with this soil in mapping are areas of soils where the surface layer contains more silt than that of this Waukee soil. Also included are a few areas where depth to sandy or gravelly material is less than 32 inches or more than 40 inches. Small areas of sand and gravel outcrops that are droughty and less productive than this Waukee soil are included. These areas are indicated on the soil map by special spot symbols.

This soil is well suited to row crops when it is properly managed. It is subject to slight erosion if it is cultivated. This soil is somewhat droughty during some years of below-normal rain. Capability unit IIe–1; woodland suitability group 3.

Waukee loam, uplands, 0 to 2 percent slopes (578A).—The largest areas of this soil are on the divide between the Cedar and Wapsipinicon Rivers. The areas are oriented from northwest to southeast. This soil is associated with Aredale, Dickinson, and Kenyon soils. This soil typically lacks gravel in the substratum. Depth to glacial till ranges from 8 feet to more than 20 feet.

Wells in this soil are drilled deep to tap underground water in the glacial till. These wells are less likely to be polluted by septic-tank effluent than are wells in Waukee soils on stream benches, which are shallower. The hazard of stream pollution from septic-tank filter fields constructed on this Waukee soil is less than the hazard on Waukee soils on stream benches.

This soil is well suited to intensive use for row crops. It is easily tilled, and little or no runoff occurs. It is somewhat droughty during years of below-normal rain. Capability unit I–1; woodland suitability group 3.

Waukee loam, uplands, 2 to 5 percent slopes (578B).—This soil is on uplands. It is commonly associated with Dickinson, Kenyon, and Sparta soils. This soil has a profile similar to the one described as representative for the series, but it is free of gravel in the lower part of the profile. Depth to glacial till ranges from 8 to more than 20 feet.

Wells in this soil are drilled deep to tap underground water in the glacial till below bedrock. These wells are less likely to be polluted by septic-tank effluent than are the wells in Waukee soils on stream benches, which are shallower. The hazard of stream pollution from septic-tank filter fields constructed on this soil is less than the hazard on Waukee soils on benches.

This soil is well suited to row crops if it is properly managed. It is subject to slight erosion if it is cultivated. This soil is somewhat droughty during years of below-normal rain. Capability unit IIe–1; woodland suitability group 3.

Waukee loam, uplands, 5 to 9 percent slopes (578C).—This soil is on uplands. It is commonly associated with Dickinson, Kenyon, and Sparta soils. This soil has a profile similar to the one described as representative for the series, but it is free of gravel in the lower part of the profile. Depth to glacial till ranges from 8 feet to more than 20 feet.

Included with this soil in mapping are small areas of moderately eroded soils that are lower in content of organic matter and in available nitrogen than this Waukee soil.

Wells in this soil are drilled deep to tap underground water. These wells will less likely be polluted by septic-tank effluent than wells in Waukee soils on stream benches, which are shallower. The hazard of stream pollution from septic-tank filter fields constructed on this soil is less than the hazard on Waukee soils on benches.

This soil is suited to row crops if it is properly managed. It is subject to erosion if it is cultivated. It is somewhat droughty during years of below-normal rain. Capability unit IIIe–1; woodland suitability group 3.

Waukegan Series

The Waukegan series consists of dark-colored, well-drained soils that formed in 30 to 40 inches of silty material and underlying sandy material. These soils are nearly level to moderately sloping and are on stream benches and on uplands. The native vegetation was mixed prairie grasses.

In a representative profile the surface layer is very dark brown silt loam about 8 inches thick. The subsurface layer is very dark grayish-brown, friable light silty clay loam about 5 inches thick. The upper 14 inches of the subsoil is brown silty clay loam. The lower part of the subsoil is brown loam that grades to dark yellowish-brown sandy loam and yellowish-brown loamy sand. The substratum, at a depth of 48 inches, is yellowish-brown loamy sand.

Waukegan soils have moderate permeability in the upper part of the profile and rapid permeability in the lower part. They have moderate available water capacity. These soils are moderately high in content of organic matter, have good tilth, and are easy to work. They are acid where they have not been limed within the last 5 years. They are low to medium in available nitrogen, low in available phosphorus, and very low in available potassium.

These soils are suited to row crops.

Representative profile of Waukegan silt loam, 2 to 5 percent slopes, in a cultivated field, 350 feet west and 170 feet south of the northeast corner of SW¼SW¼ sec. 17, T. 84 N., R. 8 W.:

- Ap—0 to 8 inches, very dark brown (10YR 2/2) silt loam; weak, fine, granular structure; friable; neutral; clear boundary.
- A3—8 to 13 inches, very dark grayish-brown (10YR 3/2) light silty clay loam; weak, fine, subangular blocky structure; friable; slightly acid; clear boundary.
- B21—13 to 18 inches, brown (10YR 4/3) silty clay loam; moderate, fine, subangular blocky structure; friable; medium acid; clear boundary.
- B22t—18 to 27 inches, brown (10YR 4/3) silty clay loam; weak, medium, subangular blocky structure; friable; few, thin, discontinuous clay films; few, thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; strongly acid; gradual boundary.
- IIB23t—27 to 32 inches, brown (10YR 4/3) loam; weak, medium, subangular blocky structure; friable; few, thin, discontinuous clay films; strongly acid; clear boundary.
- IIB31—32 to 36 inches, dark yellowish-brown (10YR 4/4) sandy loam; weak, coarse, subangular blocky structure; very friable; strongly acid; clear boundary.
- IIB32—36 to 48 inches, yellowish-brown (10YR 5/4) loamy sand; very weak, coarse, subangular blocky structure; loose; 1-inch dark-brown (10YR 3/3) bands of clay and iron at a depth of 40 to 41 inches and 46 to 47 inches; medium acid; gradual boundary.
- IIC—48 to 60 inches, yellowish-brown (10YR 5/4) loamy sand; single grain; loose; 1-inch dark-brown (10YR 3/3) band of clay and iron at a depth of 52 to 53 inches; medium acid.

The solum ranges from 40 inches to about 60 inches in thickness, and depth to contrasting textures ranges from about 30 to 40 inches. The A1 or Ap horizon typically is black (10YR 2/1) or very dark brown (10YR 2/2), and the A3 horizon is very dark brown (10YR 2/2) or very dark grayish brown (10YR 3/2). The A horizon ranges from 10 to 17 inches in thickness. The B2 horizon typically has a hue of 10YR, a value of 4 to 6, and a chroma of 3 to 6. The upper part of the B horizon formed in loess and typically is silty clay loam but ranges to silt loam. The C horizon has a hue of 10YR, a value of 4 or 5, and a chroma of 3 to 6. It generally is stratified loamy sand but in places it is sand. Reaction is medium acid to strongly acid in the most acid part of the solum.

Waukegan soils formed in material similar to that in which Tell and Waukee soils formed, and they are associated with Richwood and Waukee soils. They have a thicker, darker colored A horizon than Tell and Whittier soils. They contain less sand in the upper part of the solum than Waukee soils, and they are shallower to sand than Richwood soils.

Waukegan silt loam, 0 to 2 percent slopes (350A).—This soil is on stream benches and on uplands. It is commonly associated with Dickinson, Richwood, Waukee, and Whittier soils on stream benches and with Dinsdale and Tama soils on uplands. This soil has a profile similar to the one described as representative for the series, except that the surface layer is darker colored and thicker.

Included with this soil in mapping are a few areas of soils that contain sand at a depth as shallow as 24 inches. These soils are more droughty than this Waukegan soil.

This soil is well suited to intensive use for corn and soybeans. Capability unit I–1; woodland suitability group 3.

Waukegan silt loam, 2 to 5 percent slopes (350B).—This soil is on stream benches and on uplands. It is associated with Dickinson, Waukee, and Whittier soils on stream benches, and with Dinsdale and Tama soils on uplands. Depth to sand is generally more than 30 inches, but it is as shallow as 24 inches in cultivated, eroded areas.

This soil is well suited to row crops if it is well managed. It is subject to erosion if it is cultivated. Capability unit IIe–1; woodland suitability group 3.

Waukegan silt loam, 5 to 9 percent slopes (350C).—This soil is on stream benches and on uplands. It is commonly associated on benches with less sloping Waukegan soils and Waukee soils. On uplands it is commonly on side slopes below Dinsdale and Tama soils. This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner and depth to loamy sand is generally about 30 inches.

Included with this soil in mapping are small areas of moderately eroded soils that have a thinner surface layer and a lower content of organic matter than this Waukegan soil.

This soil is suited to row crops if it is managed well. It is subject to erosion if it is cultivated. Capability unit IIIe–1; woodland suitability group 3.

Whalan Series

The Whalan series consists of well-drained soils that formed in 20 to 30 inches of loamy glacial material underlain by limestone bedrock. These soils are moderately sloping and are on convex side slopes on uplands and on high benches. The native vegetation was trees.

In a representative profile the surface layer is a very dark grayish-brown loam about 5 inches thick. The subsurface layer is dark grayish-brown, friable loam 4 inches thick. The subsoil is brown and dark yellowish-brown loam and clay loam. The substratum, at a depth of 30 inches, is partly weathered limestone bedrock that has clay residuum around the limestone flagstones in the upper few inches.

Whalan soils have moderate permeability in the loamy material, and available water capacity is low. These soils are very low in available nitrogen, phosphorus, and potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops, but they are droughty unless rain is timely.

Representative profile of Whalan loam, moderately deep, 5 to 9 percent slopes, moderately eroded, in a pasture, 350 feet west and 20 feet south of the northeast corner of NE¼SE¼ sec. 26, T. 83 N., R. 6 W.:

- A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) loam; weak, fine, granular structure; friable; medium acid; gradual boundary.
- A2—5 to 9 inches, dark grayish-brown (10YR 4/2) loam; very dark grayish-brown (10YR 3/2) ped exteriors; weak, thin, platy structure; friable; strongly acid; clear boundary.

B1—9 to 14 inches, brown (10YR 4/3) heavy loam; dark-brown (10YR 3/3) ped exteriors; moderate, fine, subangular blocky structure; friable; discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; strongly acid; gradual boundary.

B21t—14 to 22 inches, dark yellowish-brown (10YR 4/4) light clay loam; brown (10YR 3/3) ped exteriors; moderate, medium, subangular blocky structure; friable; thin, discontinuous, dark-brown (10YR 3/3) clay films; thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; very strongly acid; gradual boundary.

B22t—22 to 29 inches, dark yellowish-brown (10YR 4/4) heavy loam; weak, coarse, subangular blocky structure; friable; thin, discontinuous, dark-brown (10YR 3/3) clay films; thin, discontinuous, light brownish-gray (10YR 6/2, dry), grainy coatings; very strongly acid; gradual boundary.

B23t—29 to 30 inches, brown (10YR 4/3) clay loam; weak, coarse, subangular blocky structure; friable; thin dark-brown (10YR 3/3) clay films and clay accumulation in old root channels; slightly acid; abrupt boundary.

IIR—30 to 40 inches, fractured limestone bedrock that has clay residuum in and around limestone flagstones in the upper few inches.

Thickness of the solum and depth to limestone bedrock range from 20 to 30 inches. The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is 3 to 5 inches thick. The A2 horizon ranges from dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) to brown (10YR 4/3 or 5/3). It is 2 to 6 inches thick. In cultivated areas the Ap horizon ranges from dark grayish brown (10YR 4/2) to brown (10YR 4/3). In some cultivated and eroded areas, the A2 horizon is wholly incorporated into the ploy layer. The B2 horizon has a hue of 10YR or 7.5YR, a value of 4 or 5, and a chroma of 3 to 6. The B2t horizon ranges from heavy loam to medium clay loam. The IIR horizon, or the residuum, typically is clay and ranges up to 6 inches in thickness, but in places it consists of thin rinds around limestone flagstones. Reaction is strongly acid to very strongly acid in the most acid part of the solum.

Whalan soils are associated with Coggon, Rockton, and Sogn soils. They are deeper over bedrock than Sogn soils. They have a thinner, lighter colored A horizon than Rockton soils. They have limestone bedrock at a depth of 20 to 30 inches, which is lacking in Coggon soils.

Whalan loam, moderately deep, 5 to 9 percent slopes, moderately eroded (207C2).—This soil is on convex side slopes and on the high part of benchlike areas. It is commonly above areas of steep Sogn soils.

Included with this soil in mapping are a few areas of soils that are less sloping than this soil and a few areas of soils that are slightly steeper. A few areas of soils that have a silty surface layer are included. Also included are a few areas where depth to bedrock is greater than 30 inches and some areas of limestone outcrops that hinder farming operations. The areas of outcrops are indicated on the soil map by a spot symbol.

This soil is suitable for row crops. Because of shallowness to bedrock, it has a limited root zone. It is droughty in most years of average rain unless rain is timely. It is subject to further erosion if it is cultivated. This soil is not well suited to terraces, because of shallowness to bedrock. Capability unit IIIe-4; woodland suitability group 3.

Whittier Series

The Whittier series consists of well-drained soils that formed in about 30 to 40 inches of silty material and underlying sandy material. These soils are nearly level to moderately sloping and are on benches and on uplands. The native vegetation was mixed prairie grasses and trees.

In a representative profile the surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsurface layer is dark grayish-brown, platy, friable silt loam about 3 inches thick. The subsoil, to a depth of 45 inches, is brown and yellowish-brown silty clay loam that grades to yellowish-brown loam and loamy fine sand in the lower part. The substratum is yellowish-brown fine sand.

Whittier soils have moderate permeability in the upper part of the profile and very rapid permeability in the lower part. They have moderate available water capacity. They are moderate to low in content of organic matter. These soils are low in available nitrogen, medium in available phosphorus, and very low in available potassium. They are acid where they have not been limed within the last 5 years.

These soils are suited to row crops.

Representative profile of Whittier silt loam, 2 to 5 percent slopes, in a cultivated field, 450 feet west and 550 feet north of the southeast corner of SE¼NW¼ sec. 26, T. 82 N., R. 6 W.:

Ap—0 to 8 inches, very dark grayish-brown (10YR 3/2) silt loam; weak cloddy, breaking to weak, fine, granular structure; friable; neutral; abrupt boundary.

A2—8 to 11 inches, dark grayish-brown (10YR 4/2) silt loam; weak, medium, platy structure breaking to weak, fine, granular structure; friable; neutral; clear boundary.

B1—11 to 15 inches, brown (10YR 4/3) light silty clay loam; dark-brown (10YR 3/3) ped exteriors; weak, fine, subangular blocky structure; friable; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings; slightly acid; gradual boundary.

B21—15 to 21 inches, yellowish-brown (10YR 5/4) medium silty clay loam; brown (10YR 4/3) ped exteriors; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings; moderate, fine, subangular blocky structure; friable; medium acid; gradual boundary.

B22t—21 to 32 inches, yellowish-brown (10YR 5/4) medium silty clay loam; brown (10YR 4/3) ped exteriors; moderate, medium, subangular blocky structure; friable; thin discontinuous clay films on peds; thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings; medium acid; gradual boundary.

B31t—32 to 37 inches, yelowish-brown (10YR 5/4) heavy loam; dark yellowish-brown (10YR 3/4) ped exteriors; weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky structure; friable; few, thin, discontinuous clay films on peds; few, thin, discontinuous, light-gray (10YR 7/2, dry), grainy coatings; medium acid; gradual boundary.

IIB32—37 to 45 inches, yellowish-brown (10YR 5/4) loamy fine sand; weak, coarse, subangular blocky structure; very friable; strongly acid; clear boundary.

IIC—45 to 60 inches, yellowish-brown (10YR 5/6) fine sand; single grain; loose; few, dark yellowish-brown (10YR 4/4) bands of clay and iron one-fourth of an inch thick; medium acid.

The solum typically ranges from 30 to 48 inches in thickness, and in places this thickness corresponds to the depth to loamy sand or sand. Depth to the sandy material typically is 30 to 40 inches, but in places it is as shallow as 24 inches. The Ap or A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is 6 to 9 inches thick. The A2 horizon is dark grayish brown (10YR 4/2) or brown (10YR 4/3). It typically is about 2 to 5 inches thick, but in some eroded areas it is wholly incorporated into the plow layer. The B2 horizon has a hue of 10YR, a value of dominantly 4 or 5, and a chroma of 3 or 4. The B2 horizon ranges from light to medium silty clay loam. The C horizon is fine sand or loamy sand. Reaction is medium acid to strongly acid in the most acid part of the solum.

Whittier soils formed in material similar to that in which Downs, Tama, Tell, and Waukegan soils formed. They have a thicker dark-colored A horizon than Tell soils. They differ

from Downs and Tama soils in that they are underlain by sand at a depth of 30 to 40 inches. They have a thinner, lighter colored A horizon than Waukegan soils.

Whittier silt loam, 0 to 2 percent slopes (352A).—This soil is on stream benches and on uplands where loess is thin over sand. It is commonly associated with Tell and Waukegan soils. Sand is generally at a depth of 36 to 40 inches.

Included with this soil in mapping are small areas of soils where sand is at a depth of about 24 inches. These areas are droughty during years of average or below-average rain unless rain is timely.

This soil is well suited to intensive use for row crops, but in some years production is reduced because of drought. Capability unit I-1; woodland suitability group 3.

Whittier silt loam, 2 to 5 percent slopes (352B).—This soil is on benches and on uplands where loess is thin over sand. It is associated with Tell and Waukegan soils. The profile of this soil is the one described as representative for the series. Sand generally is at a depth of 36 to 40 inches.

Included with this soil in mapping are small areas of soils where sand is at a depth of at least 24 inches. These areas are droughty during years of average or below-average rain unless rain is timely.

This soil is well suited to row crops if it is well managed. It is subject to slight erosion if it is cultivated. Capability unit IIe-1; woodland suitability group 3.

Whittier silt loam, 5 to 9 percent slopes, moderately eroded (352C2).—This soil is on stream benches and on convex side slopes on uplands where loess is thin over sand. It is associated with the Tell and Waukegan soils. Sand generally is at a depth of 30 to 36 inches.

Included with this soil in mapping are small areas where sand is at a depth of about 24 inches. These areas are droughty during some years of average or below-average rain unless rain is timely. Also included are small areas of soils that are less eroded than this soil; they have a darker colored surface layer and a higher content of organic matter.

This soil is suited to row crops if it is well managed. It is subject to further erosion if it is cultivated. Capability unit IIIe-1; woodland suitability group 3.

Use and Management of the Soils

This section describes briefly the use and management of the soils in the county for crops and pasture. It describes the system of capability classification used by the Soil Conservation Service, the management of the soils by capability units, and gives a table of and yield data for all the soils in the county. In addition, it discusses woodland and lists the trees suitable for planting on each of the soils in the county, briefly discusses wildlife, and gives facts about the soils that affect suitability for engineering practices.

The information given in this section is not a substitute for the detailed advice that can be provided by a local representative of the Soil Conservation Service or by the county extension service. It may, however, help the farmer or others plan suitable management for the soils.

Crops and Pasture

In 1969, according to the State of Iowa Annual Farm Census, 245,000 acres of land in Linn County was in crops, 82,000 acres was in pasture, and 71,000 acres consisted of farmland that was used for other purposes. Corn, soybeans, oats, and legume-grass are the principal crops. Most of the permanent pastures are in bluegrass. Some have been renovated and birdsfoot trefoil introduced. Grass-legume mixtures such as alfalfa-bromegrass are also pastured. Most of the areas in permanent bluegrass pasture are not used for crops, because they are wet and need tile drainage. Each year many acres are drained by tile and the areas converted to cropland. The Clyde, Floyd, and Marshan soils are the dominant ones remaining in pasture that need tile drainage.

Many soils in this county are subject to erosion. The major soils that need erosion-control practices are the Aredale, Bassett, Coggon, Dinsdale, Downs, Fayette, Kenyon, Olin, Seaton, and Tama soils. Providing adequate erosion control and drainage is difficult on the Aredale, Bassett, Coggon, Kenyon, and Olin soils, because there is an appreciable difference in the permeability of the loamy material in the surface layer and that of the glacial till in the subsoil. Water moves rapidly in the loamy material and then accumulates at the till contact, which results in a seasonably perched water table and sidehill seepage in wet years. Because of this difficulty, a combination of terracing and tiling is most likely to be effective. Erosion-control structures and grassed waterways are used to control gullying in water courses. The Tama, Dinsdale, and Downs soils and some of the Fayette soils generally have long, uniform slopes and are well suited to erosion-control practices.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are so used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, the kinds of soils are grouped at three levels: the capability class, subclass, and unit. These groups are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.

Class V soils are not likely to erode, but they have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plants and restrict their use to recreation, wildlife, water supply, or to esthetic purposes. (None in Linn County.)

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States but not in Linn County, shows that the chief limitation is climate that is too cold to too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIs-1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages the capability units in Linn County are described, and suggestions for the use and management of the soils are given.

Management of the soils by capability units

In the following pages, the capability units of Linn County are described and suggestions for the management of the soils are given. The names of soil series represented are mentioned in the description of each capability unit, but this does not mean that all the soils of a given series appear in the unit. To find the names of all the soils in any given capability unit, refer to the "Guide to Mapping Units" at the back of this survey. For a complete explanation of the capability classification, see USDA Handbook No. 210, Land-Capability Classification (*16*).

CAPABILITY UNIT I-1

This unit consists of nearly level soils of the Ardale, Bertrand, Richwood, Sattre, Tama, Waukee, Waukegan, and Whittier series. These are well-drained soils on uplands and on stream benches. They have a friable, medium-textured to moderately fine textured surface layer. The subsoil is friable, medium-textured to moderately fine textured, and moderately permeable. Sattre, Waukee, Waukegan, and Whittier soils have coarse-textured material and rapid to very rapid permeability in the substratum. Available water capacity of the soils in this unit is moderate to high. These soils are acid where they have not been limed in the last 5 years.

The soils in this unit are well aerated, warm up quickly in spring, and can be worked soon after rain. Water does not pond on the surface, although the soils are nearly level. The soils are not generally droughty, but the Sattre, Wauke, Waukegan, and Whittier soils tend to be somewhat droughty during seasons of below-normal rain.

The soils in this unit are well suited to cultivated crops, and corn, soybeans, oats, and hay are the principal crops grown. Most of the acreage of these soils is used for cultivated crops, and corn is the main crop. Soybeans are often substituted for corn in the rotation. These soils are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT I-2

This unit consists of nearly level soils of the Atterberry, Franklin, Hayfield, Klinger, Lawler, Muscatine, Nevin, Oran, Readlyn, and Stronghurst series. These are somewhat poorly drained soils on uplands and on stream benches. They have a friable, medium-textured to moderately fine textured surface layer and a friable to firm, medium-textured to moderately fine textured subsoil. They have moderate to moderately slow permeability. The Hayfield and Lawler soils and some areas of the Atterberry soils have rapid to very rapid permeability in the coarse-textured material. The soils in this unit generally have high available water capacity, but the moderately deep Lawler and Hayfield soils have moderate available water capacity. The soils in this unit have a seasonal high water table, and farm operations are delayed by excess moisture in some years. These soils are acid where they have not been limed in the last 5 years.

The soils in this unit generally are not droughty, but the Lawler and Hayfield soils and some areas of the Atterberry soils tend to be droughty during periods of below-normal rain. Water sometimes ponds on the surface for short periods. If tile drainage is used, field operations are more timely. Erosion is not generally a hazard.

These soils are suited to cultivated crops, and corn, soybeans, oats, and hay are grown. Most of the acreage is used for cultivated crops, and corn is the main crop grown. Soybeans are often substituted for corn in the rotation. These soils are also suited to pasture and trees and other to less intensive uses.

CAPABILITY UNIT I-3

This unit consists of level or nearly level soils of the Kennebec, Lawson, Nodaway, and Spillville series. These are moderately well drained to somewhat poorly drained soils that mainly are on flood plains and in narrow upland valleys. The Nodaway soils in places occur only in narrow upland drainageways. These soils have a friable, medium-textured surface layer and subsoil. They have moderate permeability and high available water capacity. These soils have a moderately high but variable water table.

The soils in this unit are not droughty, and they are not subject to erosion. They are flooded occasionally by runoff in spring and after heavy rains, and they dry out somewhat more slowly than soils in capability unit I-1. The Lawson and Spillville soils need artificial drainage in years of above-normal rain. The Nodaway soils are subject to short-duration, high-velocity flooding and are gullied in places.

The soils in this unit are well suited to row crops and are used for corn and soybeans. They are also suited to pasture and trees and to other less intensive uses. About half the acreage is in permanent pasture. Cropping patterns and production vary from year to year because of the hazard of flooding.

CAPABILITY UNIT IIe-1

This unit consists of gently sloping soils of the Aredale, Bassett, Bertrand, Dinsdale, Dodgeville, Downs, Fayette, Kenyon, Rockton, Sattre, Tama, Tell, Waubeek, Waukee, Waukegan, and Whittier series. These are moderately well drained to well drained soils on uplands and on stream benches. They have a friable, medium-textured surface layer and a friable to firm, medium-textured to fine-textured subsoil. These soils generally have moderate to moderately slow permeability, but the Sattre, Tell, Waukee, Waukegan, and Whittier soils have rapid or very rapid permeability in the substratum. Available water capacity is moderate to high in all the soils in this unit. These soils are acid where they have not been limed in the last 5 years.

All of these soils are in good tilth. The surface layer of the Bertrand, Fayette, and Tell soils tends to seal during rain, and a crust often forms as the surface layer dries. These soils generally are not droughty, but the Sattre, Tell, Waukee, Waukegan, and Whittier soils have a lower available water capacity than the other soils in this unit and are somewhat droughty in years of below-normal rainfall. The Aredale, Bassett, Dinsdale, Downs, Fayette, Kenyon, and Waubeek soils typically have long, uniform slopes and are well suited to conservation practices. Terrace cuts should be minimized to avoid exposure of the less productive glacial till subsoil in the Bassett, Dinsdale, Kenyon, and Waubeek soils; the limestone in the Dodgeville and Rockton soils; and the sandy substratum of the Sattre, Tell, Waukee, Waukegan, and Whittier soils.

The soils in this unit are well suited to corn and soybeans. They are used mainly for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIe-2

This unit consists of gently sloping soils of the Olin, Rockton, Saude, and Wapsie series. These are well-drained soils on uplands or on stream benches. They are moderately deep over bedrock, coarse-textured material, or glacial till. They have a friable, moderately coarse textured to medium-textured surface layer and a friable, moderately coarse textured to moderately fine textured subsoil. They generally have moderate to moderately rapid permeability, but the Olin soils have moderately slow permeability in the glacial till subsoil, and the Wapsie soils have rapid to very rapid permeability in the coarse-textured substratum. Available water capacity is low to moderate in the soils of this unit. These soils are acid where they have not been limed in the last 2 to 5 years.

The soils in this unit are subject to erosion. They also tend to be somewhat droughty in most years, and production is often reduced unless rain is timely. They are not well suited to the construction of terraces, because of shallowness to limestone in the Rockton soils and shallowness to sand and gravel in the Saude and Wapsie soils. The Olin soils have sand in the upper 2 feet of the profile, which makes it difficult to maintain a terrace ridge. If terraces are constructed, they should be shallow to avoid bedrock or coarse-textured material in the terrace channels. Also, the underlying limestone or sand and gravel limit, to some extent, root development of some crops.

The soils in this unit are used mainly for corn, small grain, and alfalfa, and they are suited to these crops. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIe-3

This unit consists of the gently sloping soils of the Atterberry, Donnan, Franklin, and Oran series. These soils are on uplands or on stream benches. Most of these soils are somewhat poorly drained, but the Donnan soils are somewhat poorly drained to moderately well drained. All of these soils have a friable, medium-textured surface layer and a friable to very firm, medium-textured to fine-textured subsoil. Most of them have moderate permeability, but the Oran soils have moderately slow permeability in the subsoil and the Donnan soils have very slow permeability in the clayey subsoil. All of the soils in this unit have high available water capacity. They are wet in some seasons because of the moderately high but variable water table. These soils are acid where they have not been limed in the past 5 years.

Farm operations are delayed to some extent in spring because of excess moisture in the soils. Field operations are more timely if tile drainage is used. Because of their long, gentle slopes, these soils are subject to sheet erosion. Careful placement of tile is important in the Donnan soils because permeability is very slow in the clayey subsoil. Donnan soils are not well suited to terraces, because terrace construction exposes the less productive clay sub-

soil in places, and extra water entering the soil increases the wetness limitation.

These soils are used mainly for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIe-4

This unit consists of somewhat poorly drained to well-drained soils of the Ely, Judson, and Nodaway series. These are gently sloping soils along drainageways and on alluvial fans. They have a friable, medium-textured or moderately fine textured surface layer and subsoil. These soils have moderate permeability and high available water capacity.

The soils in this unit are subject to gully and sheet erosion. They are also subject to overflow because they receive runoff from higher lying adjacent soils. Siltation is a concern during heavy rains, and also if the soils upslope are not protected from erosion. In places gullies form where water concentrates, unless grassed waterways are used to carry runoff from the hillsides to the main drainageways. In some places a combination of erosion-control structures and grassed waterways is needed to control gullies. Diversions help to control runoff from adjacent hillsides and to prevent siltation. Tile drainage is needed in some areas of the Ely and Nodaway soils.

The soils in this unit are well suited to row crops, but they generally are farmed along with adjoining soils because of their irregular, long slopes. They are used mainly for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIw-1

This unit consists of nearly level and gently sloping soils of the Clyde, Colo, Floyd, Garwin, Marshan, Maxfield, Schley, and Tripoli series, the Clyde-Floyd-Schley and Colo-Ely complexes, and the Klinger-Maxfield soils. These are generally poorly drained or somewhat poorly drained soils on uplands, on stream benches, or on bottom lands. Soils in the Clyde-Floyd-Schley and Colo-Ely complexes and the Klinger-Maxfield soils occur in narrow upland drainageways. All the soils in this unit have a friable, medium-textured or moderately fine textured surface layer and a friable to firm, medium-textured to moderately fine textured subsoil. They generally have moderate to moderately slow permeability, but the deep Marshan soils have moderate permeability in the upper part of the profile and rapid permeability in the lower part. The soils in this unit generally have high available water capacity, but the moderately deep Marshan soils have moderate available water capacity. They have a high water table or receive seepage from adjacent steeper soils. These soils generally are slightly acid to neutral and do not need very much lime, but the Schley soils are acid where they have not been limed in the last 5 years.

The Clyde and Marshan soils flood occasionally for short periods, but damage to crops is generally slight. The Colo soils are subject to flooding for longer periods, and some crop losses occur in places. Sheet erosion generally is not a concern, but the soils in the Colo-Ely and Clyde-Floyd-Schley complexes are subject to gully erosion if water concentrates. The soils in this unit dry out somewhat slowly in spring and cannot be worked soon after rains. The soils in the Clyde-Floyd-Schley complex have some stones and boulders on the surface.

If they are drained, the soils in this unit are suited to intensive use for row crops. They are used mainly for corn and soybeans but are also suited to small grain, hay, pasture and trees and to other less intensive uses. Areas that are not drained are commonly in permanent pasture or trees.

CAPABILITY UNIT IIw-2

This unit consists of nearly level soils of the Walford series. These are poorly drained soils on uplands and on stream benches. They have a friable, medium-textured surface layer and a moderately fine textured subsoil. They have slow permeability and high available water capacity. They are acid where they have not been limed in the last 5 years.

In spring or after heavy rains, the soils in this unit are wet because of a high water table, and some areas are ponded for short periods. These soils puddle after heavy rains or if they are worked when wet.

These soils are suited to row crops if they are drained, and they can be used intensively for crops if they are drained and well managed. Areas that are not drained by tile or open ditches are generally in permanent pasture. Small, isolated areas are left idle in wet years or are used as wildlife habitat.

CAPABILITY UNIT IIs-1

This unit consists of nearly level soils of the Sande and Wapsie series. These are well-drained to somewhat excessively drained soils that are moderately deep over coarse-textured material. They are dominantly on stream terraces throughout the county. These soils have a friable, medium-textured surface layer and subsoil. They have moderate to moderately rapid permeability in the surface layer and subsoil and are underlain by very rapidly permeable, coarse-textured material. Available water capacity is low to moderate. These soils are acid where they have not been limed in the last 5 years.

Droughtiness is a limitation in most years, unless rain is very timely. Tilth is generally good, and the soils in this unit are easily tilled. They also warm up quickly in spring and generally can be worked soon after rain. These soils are not subject to water erosion, but in some seasons they are subject to soil blowing. Minimum tillage practices that conserve moisture and prevent soil blowing are good management for these soils. Good growth of crops depends on the amount and timeliness of rain.

These soils are suited to cultivated crops, and the principal crops grown are corn, soybeans, small grain, and alfalfa. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIs-2

This unit consists of nearly level soils of the Hayfield and Lawler series. These are somewhat poorly drained soils that are moderately deep over sand and gravel. They are dominantly on stream benches throughout the county. These soils have a friable, medium-textured surface layer and subsoil. They have moderate permeability in the surface layer and in the subsoil, but they are underlain by rapidly permeable sand and gravel. Available water capacity is low to moderate. These soils are acid where they have not been limed in the last 5 years.

The soils in this unit have a fluctuating water table that is moderately high in spring but drops rapidly during the growing season. Droughtiness is a limitation, especially in years of average or below-average rain. These soils benefit from artificial drainage during wet seasons, but placement of tile is difficult because of the loose, water-bearing sand and gravel.

These soils are suited to cultivated crops. They are used mainly for corn, soybeans, small grain, and alfalfa, but they are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIIe-1

This unit consists of moderately sloping soils of the Arcdale, Bassett, Coggon, Dinsdale, Dodgeville, Donnan, Downs, Fayette, Kenyon, Olin, Rockton, Sattre, Tama, Tell, Waubeek, Waukee, Waukegan, and Whittier series. These are slightly eroded or moderately eroded soils on uplands or on stream benches. They generally are moderately well drained to well drained, but the Donnan soils are somewhat poorly drained to moderately well drained. The soils in this unit have a friable, moderately coarse textured to moderately fine textured surface layer. The subsoil is very friable to very firm and moderately coarse textured to fine textured. Available water capacity is moderate to high, and permeability is rapid to very slow. These soils are acid where they have not been limed.

The soils in this unit are suited to contouring, stripcropping, or terracing, and minimum tillage also helps to control erosion in cultivated areas. Dinsdale, Downs, Kenyon, and Tama soils commonly have long, uniform slopes and are well suited to terraces. In places the underlying limestone in the Dodgeville and Rockton soils interferes with terrace construction. Terrace cuts should be minimized in the Bassett, Coggon, Dinsdale, Kenyon, and Waubeek soils to avoid exposing the less productive glacial till subsoil. Terrace cuts should be minimized in the Sattre, Tell, Waukee, Waukegan, and Whittier soils to avoid exposing the underlying sand and gravel. The Donnan soils are not well suited to terraces because in places terrace construction exposes the less productive, very slowly permeable, clayey subsoil, and the extra water that enters the soil increases the wetness limitation. Grassed waterways are needed to prevent formation of gullies in areas where water concentrates. The surface layer of the Coggon, Fayette, and Tell soils tends to seal, and a crust often forms as the surface layer dries. The deep Dodgeville, Olin, deep Rockton, Sattre, Tell, Waukee, Waukegan, and Whittier soils tend to be somewhat droughty in some years unless rain is timely. Donnan and Olin soils are seepy in places, especially after periods of heavy rain. To maintain good tilth, all crop residue should be returned to the soil.

The soils in this unit are suited to row crops if further erosion is controlled. Corn is grown most frequently, but soybeans are sometimes substituted for corn in the rotation. Although these soils are used mainly for corn, soybeans, small grain, and alfalfa, they are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIIe-2

This unit consists of strongly sloping, slightly eroded and moderately eroded soils of the Bassett, Downs, Fayette, Kenyon, and Seaton series. These are moderately well drained to well drained soils on uplands. These soils have a friable, medium-textured surface layer and a friable to firm, medium-textured to moderately fine textured subsoil. Available water capacity is high, and permeability is moderately slow to moderate. These soils are generally acid where they have not been limed in the last 5 years, except for some areas of Seaton soils.

Management practices suited to the soils of this unit are contouring, terracing, stripcropping, and minimum tillage. Terrace cuts should be minimized in the Bassett and Kenyon soils to avoid exposing the less productive glacial till subsoil. Grassed waterways are needed to prevent the formation of gullies in areas where water concentrates. To maintain tilth, especially in the Fayette and Seaton soils, all crop residue should be returned to the soil.

The soils in this unit are used for corn, soybeans, small grain, and alfalfa. They are also suited to pasture and trees and to other less intensive uses. They are suited to cultivated crops if further erosion is controlled.

CAPABILITY UNIT IIIe-3

This unit consists of gently sloping to moderately sloping soils of the Dickinson, Flagler, Lamont, and Saude series and of moderately sloping soils of the Chelsea-Lamont-Fayette and Dickinson-Sparta-Tama complexes. These are well-drained to excessively drained, slightly eroded to moderately eroded soils on uplands or on stream benches. These soils, except for the Fayette and Tama soils, have a very friable, coarse-textured to medium-textured surface layer and subsoil. The Fayette and Tama soils have a friable, medium-textured or moderately fine textured surface layer and a moderately fine textured subsoil. The substratum is coarse textured in all the soils in this unit, except in the Dickinson soils, which have a loam substratum. Except for the Fayette and Tama soils, the soils in this unit have moderately slow to very rapid permeability and moderate to very low available water capacity. The sandy soils of this unit have a low to moderate content of organic matter. Fayette and Tama soils are moderately permeable and have high available water capacity. Fayette soils are low in content of organic matter. All the soils in this unit are acid where they have not been limed in the last 2 to 4 years.

Use of the soils of this unit is limited by steepness of slope and droughtiness. On the sandy soils, blowing sand damages recently seeded crops in places. The surface layer of the Fayette soils tends to seal, and a crust often forms as the surface layer dries. Contour minimum tillage or contour stripcropping helps to control erosion and to conserve moisture on the gently sloping to moderately sloping sandy soils. The soils in this complex commonly have short, irregular slopes, and erosion-control practices are difficult to apply. Terraces are difficult to construct and maintain on the sandy soils.

The soils in this unit are suited to corn, soybeans, oats, and hay, and they are used mainly for these crops. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIIe-4

This unit consists of moderately sloping soils of the Rockton and Whalan series. These soils are moderately

deep over limestone bedrock. They are well-drained and slightly eroded to moderately eroded. They have a friable, medium-textured surface layer and a friable, medium-textured or moderately fine textured subsoil. Limestone bedrock is at a depth of 20 to 30 inches. These soils have moderate permeability and low available water capacity. They are acid where they have not been limed in the last 5 years.

The soils in this unit are subject to erosion and tend to be droughty because of shallowness to limestone bedrock. They are easily tilled, warm up quickly in spring, and can be worked soon after rains. Most areas are poorly suited to terraces because of shallowness to bedrock.

These soils are used mainly for corn, oats, and alfalfa. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IIIw-1

This unit consists of Muck soils. These are nearly level to gently sloping, organic soils that are shallow and moderately shallow. They are very poorly drained soils on uplands and on stream benches. They have a spongy surface layer that consists mainly of organic matter. The organic layer is underlain by soil material that is very friable to friable and moderately coarse textured to moderately fine textured. The shallow soils have 10 to 20 inches of organic matter over mineral soil material, and the moderately shallow soils have 20 to 40 inches of organic matter over mineral soil material. The soils in this unit have very high available water capacity. Permeability is slow to moderately rapid in the surface layer, depending on whether the areas are artificially drained. These soils are slightly acid to neutral.

Wetness is a limitation to use of the soils in this unit because of a high water table and sidehill seepage. Areas that have not been drained have a water table that is at or near the surface. Because the surface layer is irregular, water ponds in places. When the soils are artificially drained, the organic matter settles. If tile is placed in the organic material, shrinkage of this material alters the alinement of the tile, causing it to function improperly. Tile drains function better if they are placed in the underlying mineral soil material. In some areas outlets are difficult to obtain.

The areas of muck in Linn County are generally not very large, but some are large enough to be used for such specialty vegetable crops as potatoes and onions. These soils are moderately suited to row crops if they are well managed and artificially drained. Drained areas are used mainly for corn or soybeans. These soils are suited to oats, but they are subject to lodging. Early maturing crops should be grown because of the hazard of frost, which is more severe on these soils than on those in adjoining areas. Undrained areas are poorly suited to pasture and generally are left idle because the spongy surface layer does not withstand grazing livestock.

CAPABILITY UNIT IIIw-2

The only soil in this unit is Donnan loam, gray subsoil variant. This is a nearly level, poorly drained soil on uplands. It has a friable, medium-textured surface layer and a friable to very firm, moderately fine textured or fine textured subsoil. The surface layer is moderately permeable, but the subsoil is slowly to very slowly permeable. Available water capacity is high. This soil is acid where it has not been limed in the last 5 years.

This soil is generally wet and ponded during periods of prolonged or heavy rain. Either tile or open-ditch drainage is needed. Field operations often are delayed in spring, even if this soil is artificially drained.

This soil is suited to row crops if it is drained. Some areas are large enough to be farmed, but most areas consist of small, isolated pockets. These small areas are left idle in some wet years when the surrounding soils are cultivated. Corn and soybeans are the principal crops, but the rotation generally is the same as in the surrounding soils. Undrained areas are commonly in permanent pasture or are left idle and used as wildlife habitat.

CAPABILITY UNIT IIIs-1

This unit consists of nearly level soils of the Dickinson and Flagler series. These are well-drained to somewhat excessively drained soils on uplands or on stream benches. They have a very friable, coarse-textured to moderately coarse textured surface layer and subsoil. The substratum is coarse textured. These soils have moderately rapid to very rapid permeability and low to very low available water capacity. All of these soils are acid where they have not been limed in the last 2 to 5 years.

Droughtiness limits the use of the soils of this unit for crops, and soil blowing also is a hazard if the surface is unprotected. Blowing sand sometimes damages newly seeded crops. Minimum tillage practices and leaving crop residue on the surface help to control soil blowing and to conserve moisture.

These soils are moderately well suited to row crops, but production depends on the amount and timeliness of rain. They are used mainly for corn or soybeans, oats, and alfalfa. They are also suited to pasture and trees and to other less intensive uses.

CAPABILITY UNIT IVe-1

This unit consists of moderately well drained to well drained soils of the Bassett, Fayette, and Seaton series. These are moderately steep, slightly eroded and moderately eroded or strongly sloping, severely eroded soils on uplands. These soils have a friable, medium-textured surface layer, but the clay content is commonly a little higher where they are severely eroded. The subsoil is friable to firm and medium-textured to moderately fine textured. These soils generally have moderate permeability, but the Bassett soils have moderately slow permeability. Available water capacity is high in the soils of this unit. These soils generally are acid in areas that are not limed, but some areas of the Seaton soils are neutral to moderately alkaline.

Further erosion is a severe hazard on the soils of this unit because runoff is rapid. The surface layer tends to seal during rains, and a crust forms when the soil dries, especially in the Fayette and Seaton soils. If row crops are grown, the crop residue should be left on the surface. Cultivated areas should be contour tilled to prevent excess soil loss. Gullies and drainageways need to be shaped and reseeded in places.

These soils are better suited to hay and pasture than to cultivated crops. Corn generally is grown only in rotation to reestablish the grass and legumes for hay and pasture. Soybeans are generally not substituted for corn

in the rotation, because they permit more erosion to take place. Areas that are difficult to farm are well suited to trees and to wildlife habitat.

CAPABILITY UNIT IVe-2

This unit consists of strongly sloping soils of the Dickinson series, moderately deep soils of the Rockton series, and soils of the Dickinson-Sparta-Tama complex. These are well-drained to excessively drained, slightly eroded to moderately eroded soils on uplands and on stream benches. These soils have a friable to very friable, coarse-textured to moderately fine textured surface layer and subsoil. The Dickinson and Sparta soils have a coarse-textured substratum. The Rockton soils have limestone bedrock at a depth of about 2 feet. Permeability of the soils in this unit is moderate to very rapid. Available water capacity is very low to high. All these soils are acid where they have not been limed in the last 2 to 5 years.

In places establishing new seedlings on the sandy soils is difficult. Crop residue left on the surface helps to control blowing and water erosion and to conserve moisture. The sandy soils are not very well suited to terraces, because terraces are difficult to construct and to maintain. Terraces generally are not constructed on the Rockton soils, because of shallowness to limestone bedrock. Contouring, stripcropping, and minimum tillage reduce soil losses.

The soils of this unit are better suited to hay and pasture than to cultivated crops because they are subject to further erosion and are droughty. Production depends on the amount and timeliness of rain. Areas difficult to farm are well suited to trees and to wildlife habitat. Corn and oats generally are grown only to reestablish new seedlings.

CAPABILITY UNIT IVs-1

This unit consists of nearly level to moderately sloping soils of the Bertram, Burkhardt, Chelsea, Sogn, and Sparta series. These are somewhat excessively drained and excessively drained soils. The Burkhardt, Chelsea, and Sparta soils are on stream benches or on uplands, and the other soils are on uplands. These soils have a friable to very friable, coarse-textured to medium-textured surface layer. They have a very friable to firm, coarse-textured to moderately fine textured subsoil. Bertram soils have limestone at a depth of 20 to 40 inches, and Sogn soils have limestone at a depth of less than 15 inches. Burkhardt, Chelsea, and Sparta soils have very rapid permeability. Bertram soils have rapid permeability in the sandy material and moderately low permeability in the clayey residuum. Sparta soils that have a loam substratum have very rapid permeability in the sandy material, but moderately slow permeability in the glacial till, or lower subsoil. Sogn soils have moderate permeability. Available water capacity in all the soils in this unit is low to very low. These soils generally are acid where they have not been limed in the last 2 or 3 years, but the Sogn soils generally do not require lime.

Droughtiness is the principal limitation to use of the soils in this unit, and soil blowing is a hazard except on the Sogn soils. In places blowing sand damages new seedlings, not only on these soils, but also on adjacent soils. These soils warm up quickly in spring and can be worked very soon after rain. They absorb moisture readily but lose much of it through deep percolation. Sloping soils are subject to sheet erosion. On the nearly level Chelsea and Sparta soils, where water erosion is not a hazard, minimum tillage practices and leaving crop residue on the surface help to control soil blowing and to conserve moisture. On the gently sloping and moderately sloping Bertram, Burkhardt, Chelsea, and Sparta soils, contouring and minimum tillage practices reduce both water erosion and soil blowing and conserve moisture. During wet periods, the Sparta soils that have a loam substratum are seepy because the water goes through the sandy material rapidly but moves laterally through the till more slowly.

Although a few areas of Sogn soils are used for row crops, the soils in this unit are better suited to permanent hay, pasture, and wildlife habitat. They are also suited to certain kinds of trees and to other less intensive uses. These soils are too droughty and too shallow for row crops and are subject to erosion if they are cultivated and not protected. Good growth of crops depends on the timeliness of rain during the growing season.

CAPABILITY UNIT Vw-1

This unit consists only of Loamy alluvial land. It is nearly level and is on bottom lands, and the areas are generally cut by stream channels and oxbows. This land type is coarse textured to moderately fine textured. It is well drained to very poorly drained. Available water capacity and permeability vary. Reaction is slightly acid to neutral.

This land type is frequently flooded, and wetness is the major limitation. In many places water is ponded during a part of the year, and the water table is high.

Without major reclamation, this land type is better suited to pasture, woods, or wildlife habitat than to cultivated crops. If cultivated crops are grown, land leveling, flood control, and surface drainage are needed in many places. Most of the areas are in permanent pasture or woodland, but a few areas are cultivated along with areas of adjacent soils.

CAPABILITY UNIT VIe-1

This unit consists of moderately steep soils of the Fayette series, steep to very steep soils of the Bassett and Fayette series, and strongly sloping to moderately steep soils of the Chelsea-Lamont-Fayette complex. These are moderately well drained to excessively drained, slightly eroded to severely eroded soils on uplands. These soils have a very friable to friable, coarse-textured to moderately fine textured surface layer. They have a very friable to firm, coarse-textured to moderately fine textured subsoil. Available water capacity is high in the Bassett and Fayette soils, low in the Lamont soils, and very low in the Chelsea soils. Permeability is very rapid in the sandy Chelsea and Lamont soils, moderate in the Fayette soils, and moderately slow in the Bassett soils. All these soils are acid where they have not been limed.

The soils of this unit are subject to further erosion by runoff if the areas are barren or if vegetation is sparse. In some places gullies have formed. The eroded areas have poor tilth, and the surface layer tends to seal during heavy rain. Waterways and gullies can be shaped and seeded. Diversion terraces help to protect the soils downslope from runoff and siltation. Small areas that are

within larger areas of more productive soils can be left in meadow when the adjoining soils are cultivated. These areas should be plowed only when the meadow needs reseeding.

These soils are not well suited to cultivated crops. They are better suited to permanent pasture and trees than to other uses. Row crops are generally grown only in a rotation to reestablish hay and pasture.

CAPABILITY UNIT VIs-1

This unit consists of strongly sloping to moderately steep soils of the Burkhardt, Chelsea, Sogn, and Sparta series. These are somewhat excessively drained to excessively drained soils on stream benches or on uplands. They have a friable to very friable, coarse-textured to medium-textured surface layer and a very friable, coarse-textured subsoil. The Sogn soils have limestone at a depth of less than 15 inches, and limestone outcrops are present in many places. Chelsea and Sparta soils are sandy, and Burkhardt soils are underlain by gravelly sand at a shallow depth. Burkhardt, Chelsea, and Sparta soils have very rapid permeability, and the Sogn soils have moderate permeability. Available water capacity is very low in the soils of this unit. The Sogn soils are neutral, but the other soils are acid where they have not been limed in the last 2 or 3 years.

The soils of this unit absorb moisture readily but lose much of the moisture through deep percolation. In places establishing new seedlings for pasture is difficult on the Chelsea and Sparta soils because of their sandy surface layer. Leaving crop residue on the surface helps to control erosion, protects seedlings from blowing sand, and conserves moisture. Controlled grazing helps to maintain good stands of pasture.

These soils are not suited to cultivated crops, because they are droughty and subject to erosion. They are better suited to pasture, trees, and wildlife habitat than to most other purposes. Small areas that are left idle provide good habitat for wildlife. Trees of suitable species grow reasonably well in places, and these areas should be protected from grazing.

CAPABILITY UNIT VIIe-1

This unit consists of steep to very steep soils of the Seaton series and of the Chelsea-Lamont-Fayette complexes. These are well-drained to excessively drained soils on uplands. They are slightly eroded to moderately eroded, but in places they contain gullies and deep drainageways that have cut into the hillsides. The surface layer of the Fayette and Seaton soils is friable and medium textured, and the subsoil is friable and medium textured to moderately fine textured. The Lamont and Chelsea soils have a very friable, moderately coarse textured to coarse textured surface layer and a coarse-textured subsoil. The Fayette and Seaton soils have high available water capacity and moderate permeability. The Chelsea and Lamont soils have very low to low availble water capacity and moderately rapid to very rapid permeability. All of the soils in this unit are acid where they have not been limed.

The soils of this unit are not suited to cultivated crops and are only poorly suited to pasture. Most areas of these soils are wooded. Although some open areas have limited use for pasture early in summer, the carrying capacity is low, and grazing needs to be carefully controlled to ensure a permanent cover of vegetation. If these soils are used for woods, fencing is needed to prevent grazing. Renovation of pastures is difficult because of the steep slopes. These soils provide excellent habitat for wildlife.

CAPABILITY UNIT VIIw-1

Only Marsh is in this unit. It consists of areas that are covered by water most of the time. These areas generally are not suited to farming. Waterfowl, muskrats and upland game animals find food and nesting places in areas of Marsh and around its edges.

These areas can be improved for use as wildlife habitat by maintaining a more constant water level. Areas of Marsh can provide opportunities for income and recreation in the form of trapping muskrat and selling hunting privileges.

CAPABILITY UNIT VIIs-1

This unit consists of moderately steep to very steep soils of the Chelsea and Sogn series and of steep to very steep Loamy terrace escarpments and Steep rock land. These soils are well drained to excessively drained. The Chelsea soils have a very friable, coarse-textured surface layer and subsoil. The Sogn soils have a surface layer that is thin and medium textured, and limestone bedrock is at a depth of less than 15 inches. Loamy terrace escarpments have a surface layer and subsoil that are medium textured to coarse textured. Steep rock land has little soil material on the surface, and it ranges from medium textured to coarse textured. The areas are very steep. This soil material is between fragments of limestone and in fractures in the bedrock. The Chelsea soils and Loamy terrace escarpments have very rapid permeability, Sogn soils have moderate permeability, and Steep rock land has moderate to very rapid permeability. Available water capacity for the soils in this unit is very low.

Use of these soils for farming is extremely limited. Most areas are in woods or in permanent pasture. Renovation of pastures is difficult, because the areas are commonly too steep for the use of regular farm machinery. Carrying capacity of pastures is low, and grazing needs to be controlled to prevent erosion. Some limestone quarries are in areas of Sogn soils and Steep rock land. A few sand or gravel pits are in areas of Chelsea soils and Loamy terrace escarpments. Steep rock land has some scenic value.

Predicted yields

In table 2 the average acre yields of the principal crops of Linn County are predicted for soils under a high level of management. Under this level of management, seedbed preparation, planting, and tillage practices provide for adequate stands of suited varieties; erosion is controlled; the organic-matter content and soil tilth are maintained; the level of fertility for each crop is maintained, as indicated by soil tests and field trials; the water level in wet soils is controlled; excellent weed and pest control is provided; and operations are timely.

Many available sources of yield information were used to make these estimates, including data from the U.S. Census and the Iowa Farm Census, data from experimental farms and cooperative experiments with farmers, and from on-farm experience by soil scientists, extension workers, and others.

TABLE 2.—*Predicted average acre yields of principal crops under high level of management*

[Dashes indicate that the crop is not suited to the soil or is not generally grown on it]

Soil	Corn	Soy-beans	Oats	Alfalfa-brome hay	Alfalfa-brome pasture
	Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Aredale loam, 0 to 2 percent slopes	115	44	92	4.8	240
Aredale loam, 2 to 5 percent slopes	113	43	90	4.7	235
Aredale loam, 5 to 9 percent slopes	108	41	86	4.5	225
Atterberry silt loam, 0 to 2 percent slopes	125	47	93	5.0	250
Atterberry silt loam, 2 to 5 percent slopes	123	46	92	5.0	250
Atterberry silt loam, benches, 0 to 2 percent slopes	125	47	93	5.0	250
Atterberry silt loam, sandy substratum, 0 to 2 percent slopes	95	36	76	4.0	200
Bassett loam, 2 to 5 percent slopes	107	40	86	4.5	225
Bassett loam, 5 to 9 percent slopes	102	39	82	4.3	215
Bassett loam, 5 to 9 percent slopes, moderately eroded	99	38	80	4.1	205
Bassett loam, 9 to 14 percent slopes, moderately eroded	90	34	72	3.8	190
Bassett loam, 14 to 18 percent slopes, moderately eroded	75	28	60	3.2	160
Bassett loam, 18 to 30 percent slopes, moderately eroded	---	---	25	2.4	120
Bertram sandy loam, 2 to 5 percent slopes	65	25	45	2.2	110
Bertram sandy loam, 5 to 9 percent slopes	50	19	35	2.1	105
Bertrand silt loam, 0 to 2 percent slopes	110	42	88	4.6	230
Bertrand silt loam, 2 to 5 percent slopes	108	41	86	4.5	225
Burkhardt sandy loam, 2 to 9 percent slopes	45	17	36	1.6	80
Burkhardt sandy loam, 9 to 14 percent slopes, moderately eroded	30	11	24	1.0	50
Chelsea loamy fine sand, 0 to 2 percent slopes	59	22	47	2.5	125
Chelsea loamy fine sand, 2 to 5 percent slopes	57	21	46	2.4	120
Chelsea loamy fine sand, 5 to 9 percent slopes	52	20	41	2.2	110
Chelsea loamy fine sand, 9 to 18 percent slopes	40	15	32	1.5	75
Chelsea loamy fine sand, 18 to 30 percent slopes	---	---	20	1.0	50
Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes	75	29	60	3.2	160
Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes, moderately eroded	72	27	58	3.0	150
Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes	50	20	40	2.3	115
Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes, moderately eroded	40	15	35	2.1	105
Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes	---	---	---	---	85
Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes, moderately eroded	---	---	---	---	75
Clyde silty clay loam	102	39	82	4.0	200
Clyde-Floyd-Schley complex, 1 to 4 percent slopes	100	38	80	4.2	210
Coggon loam, 5 to 9 percent slopes, moderately eroded	93	35	74	3.8	190
Colo silt loam, overwash	106	40	85	4.5	225
Colo silty clay loam	104	40	83	4.4	220
Colo-Ely complex, 2 to 5 percent slopes	105	40	84	4.4	220
Dickinson fine sandy loam, 0 to 2 percent slopes	83	32	67	3.5	175
Dickinson fine sandy loam, 2 to 5 percent slopes	81	31	65	3.4	170
Dickinson fine sandy loam, 5 to 9 percent slopes	76	29	61	3.2	160
Dickinson fine sandy loam, 9 to 14 percent slopes	67	25	54	2.8	140
Dickinson fine sandy loam, loam substratum, 2 to 5 percent slopes	86	33	69	3.6	180
Dickinson fine sandy loam, loam substratum, 5 to 9 percent slopes	81	31	65	3.4	170
Dickinson-Sparta-Tama complex, 5 to 9 percent slopes	88	33	70	3.7	185
Dickinson-Sparta-Tama complex, 9 to 14 percent slopes	79	30	63	3.3	165
Dinsdale silty clay loam, 2 to 5 percent slopes	119	45	95	5.0	250
Dinsdale silty clay loam, 5 to 9 percent slopes	114	43	91	4.8	240
Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded	111	42	89	4.7	235
Dodgeville silt loam, deep, 2 to 5 percent slopes	100	38	80	4.2	210
Dodgeville silt loam, deep, 5 to 9 percent slopes	90	34	72	3.8	190
Donnan loam, 2 to 5 percent slopes	70	26	56	2.9	145
Donnan loam, 5 to 9 percent slopes, moderately eroded	60	22	48	2.5	125
Donnan loam, gray subsoil variant	65	25	52	2.7	135
Downs silt loam, 2 to 5 percent slopes	119	45	95	5.0	250
Downs silt loam, 5 to 9 percent slopes	114	43	91	4.8	240
Downs silt loam, 5 to 9 percent slopes, moderately eroded	111	42	89	4.7	235
Downs silt loam, 9 to 14 percent slopes	105	40	84	4.4	220
Downs silt loam, 9 to 14 percent slopes, moderately eroded	102	39	82	4.3	215
Ely silt loam, 2 to 5 percent slopes	124	47	99	5.2	260
Fayette silt loam, 2 to 5 percent slopes	113	43	90	4.7	235
Fayette silt loam, 5 to 9 percent slopes	108	41	86	4.5	225
Fayette silt loam, 5 to 9 percent slopes, moderately eroded	105	40	84	4.4	220
Fayette silt loam, 9 to 14 percent slopes	99	38	80	4.2	210
Fayette silt loam, 9 to 14 percent slopes, moderately eroded	96	36	76	4.0	200
Fayette silt loam, 9 to 14 percent slopes, severely eroded	90	34	72	3.8	190
Fayette silt loam, 14 to 18 percent slopes	84	32	67	3.5	175
Fayette silt loam, 14 to 18 percent slopes, moderately eroded	81	31	65	3.4	170
Fayette silt loam, 14 to 18 percent slopes, severely eroded	---	---	62	3.2	160

See footnote at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under high level of management*—Continued

Soil	Corn	Soy-beans	Oats	Alfalfa-brome hay	Alfalfa-brome pasture
	Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Fayette silt loam, 18 to 30 percent slopes	-------	-------	40	3.0	165
Fayette silt loam, 18 to 30 percent slopes, moderately eroded	-------	-------	40	2.8	160
Fayette silt loam, benches, 2 to 5 percent slopes	113	43	90	4.7	235
Flagler sandy loam, 0 to 2 percent slopes	70	27	56	2.9	145
Flagler sandy loam, 2 to 5 percent slopes	68	26	54	2.8	140
Flagler sandy loam, 5 to 9 percent slopes	63	24	50	2.6	130
Flagler sandy loam, 5 to 9 percent slopes, moderately eroded	60	23	48	2.5	125
Floyd loam, 1 to 4 percent slopes	106	40	85	4.5	225
Franklin silt loam, 0 to 2 percent slopes	119	45	89	5.0	250
Franklin silt loam, 2 to 5 percent slopes	117	44	87	5.0	250
Garwin silty clay loam	125	47	94	5.0	250
Hayfield loam, deep	94	36	75	4.0	200
Hayfield loam, moderately deep	79	30	63	3.0	150
Judson silty clay loam, 2 to 5 percent slopes	124	47	93	5.2	260
Kennebec silt loam	124	47	93	5.2	260
Kenyon loam, 2 to 5 percent slopes	113	43	90	4.7	235
Kenyon loam, 5 to 9 percent slopes	108	41	86	4.5	225
Kenyon loam, 5 to 9 percent slopes, moderately eroded	105	40	84	4.4	220
Kenyon loam, 9 to 14 percent slopes, moderately eroded	96	36	76	4.0	200
Klinger silty clay loam, 0 to 2 percent slopes	125	47	93	5.2	260
Klinger-Maxfield silty clay loams, 2 to 5 percent slopes	115	43	86	4.8	240
Lamont fine sandy loam, 2 to 5 percent slopes	69	26	52	2.5	125
Lamont fine sandy loam, 5 to 9 percent slopes	64	24	48	2.3	115
Lawler loam, deep	100	38	80	4.2	210
Lawler loam, moderately deep	85	32	68	3.6	180
Lawson silt loam	119	45	90	5.0	250
Loamy alluvial land	-------	-------	-------	-------	-------
Loamy terrace escarpments, 14 to 30 percent slopes	-------	-------	-------	-------	75
Marsh	-------	-------	-------	-------	-------
Marshan silty clay loam, deep	101	38	81	4.0	200
Marshan silty clay loam, moderately deep	91	35	73	3.8	190
Maxfield silty clay loam	119	45	89	5.0	250
Muck, shallow	104	40	83	3.9	190
Muck, moderately shallow	89	34	71	3.4	180
Muscatine silty clay loam, 1 to 3 percent slopes	130	50	97	5.5	275
Muscatine silty clay loam, benches, 0 to 2 percent slopes	130	50	97	5.5	275
Nevin silty clay loam	114	43	63	4.8	240
Nodaway silt loam, 0 to 2 percent slopes	114	43	63	4.8	240
Nodaway silt loam, 2 to 5 percent slopes	112	43	62	4.7	230
Olin fine sandy loam, 2 to 5 percent slopes	97	37	73	4.1	205
Olin fine sandy loam, 5 to 9 percent slopes	92	35	70	3.9	195
Oran loam, 0 to 2 percent slopes	109	41	87	4.6	230
Oran loam, 2 to 5 percent slopes	107	40	85	4.5	225
Readlyn loam, 0 to 2 percent slopes	115	44	92	4.8	240
Richwood silt loam	122	46	98	5.1	255
Rockton loam, deep, 2 to 5 percent slopes	96	36	77	4.0	200
Rockton loam, deep, 5 to 9 percent slopes	91	35	73	3.8	190
Rockton loam, moderately deep, 2 to 5 percent slopes	76	29	60	3.0	180
Rockton loam, moderately deep, 5 to 9 percent slopes	71	27	57	2.8	140
Rockton loam, moderately deep, 9 to 14 percent slopes	62	24	49	2.5	125
Sattre loam, 0 to 2 percent slopes	93	35	75	3.9	195
Sattre loam, 2 to 5 percent slopes	91	34	73	3.8	190
Sattre loam, 5 to 9 percent slopes, moderately eroded	83	31	66	3.5	175
Saude loam, 0 to 2 percent slopes	85	32	68	3.6	180
Saude loam, 2 to 5 percent slopes	83	31	67	3.5	175
Saude loam, 5 to 9 percent slopes	78	29	62	3.3	165
Schley loam, 1 to 4 percent slopes	100	38	80	4.2	210
Seaton silt loam, 9 to 14 percent slopes	99	38	80	4.2	210
Seaton silt loam, 9 to 14 percent slopes, moderately eroded	96	36	76	4.0	200
Seaton silt loam, 14 to 18 percent slopes	84	32	67	3.5	175
Seaton silt loam, 14 to 18 percent slopes, moderately eroded	81	31	65	3.4	170
Seaton silt loam, 18 to 30 percent slopes	-------	-------	60	3.0	150
Seaton silt loam, 18 to 30 percent slopes, moderately eroded	-------	-------	40	2.0	100
Sogn loam, 5 to 9 percent slopes	41	16	33	1.8	90
Sogn loam, 9 to 18 percent slopes	-------	-------	24	1.4	70
Sogn loam, 18 to 30 percent slopes	-------	-------	-------	-------	50
Sparta loamy fine sand, 0 to 2 percent slopes	63	24	47	2.6	130
Sparta loamy fine sand, 2 to 5 percent slopes	61	23	45	2.6	130
Sparta loamy fine sand, 5 to 9 percent slopes	56	21	42	2.3	115

See footnote at end of table.

TABLE 2.—*Predicted average acre yields of principal crops under high level of management*—Continued

Soil	Corn	Soy-beans	Oats	Alfalfa-brome hay	Alfalfa-brome pasture
	Bu.	*Bu.*	*Bu.*	*Tons*	*Animal-unit-days* [1]
Sparta loamy fine sand, 9 to 18 percent slopes			35	2.2	110
Sparta loamy fine sand, loam substratum, 2 to 5 percent slopes	65	25	52	2.7	135
Sparta loamy fine sand, loam substratum, 5 to 9 percent slopes	60	23	48	2.5	125
Spillville loam	122	46	98	5.1	260
Steep rock land					
Stronghurst silt loam, 0 to 2 percent slopes	119	45	95	5.0	250
Tama silty clay loam, 0 to 2 percent slopes	127	48	95	5.2	260
Tama silty clay loam, 2 to 5 percent slopes	125	48	95	5.2	260
Tama silty clay loam, 5 to 9 percent slopes	120	46	90	5.0	250
Tama silty clay loam, 5 to 9 percent slopes, moderately eroded	117	44	88	4.9	245
Tama silty clay loam, benches, 0 to 2 percent slopes	127	48	95	5.2	260
Tama silty clay loam, benches, 2 to 5 percent slopes	125	48	95	5.2	260
Tell silt loam, 2 to 5 percent slopes	80	30	64	3.3	165
Tell silt loam, 5 to 9 percent slopes, moderately eroded	72	27	58	3.0	150
Tripoli silty clay loam	111	42	89	4.5	225
Walford silt loam	99	38	75	3.5	175
Walford silt loam, benches	99	38	75	3.5	175
Wapsie loam, 0 to 2 percent slopes	72	27	57	3.0	150
Wapsie loam, 2 to 5 percent slopes	70	27	56	2.9	145
Waubeek silt loam, 2 to 5 percent slopes	113	43	85	4.7	235
Waubeek silt loam, 5 to 9 percent slopes, moderately eroded	105	40	79	4.4	220
Waukee loam, 0 to 2 percent slopes	98	37	78	4.1	205
Waukee loam, 2 to 5 percent slopes	96	36	77	4.0	200
Waukee loam, uplands, 0 to 2 percent slopes	98	37	78	4.1	205
Waukee loam, uplands, 2 to 5 percent slopes	96	36	77	4.0	200
Waukee loam, uplands, 5 to 9 percent slopes	85	32	68	3.5	175
Waukegan silt loam, 0 to 2 percent slopes	95	36	76	4.0	200
Waukegan silt loam, 2 to 5 percent slopes	93	35	74	3.9	195
Waukegan silt loam, 5 to 9 percent slopes	88	33	70	3.7	185
Whalan loam, moderately deep, 5 to 9 percent slopes, moderately eroded	59	22	47	2.5	125
Whittier silt loam, 0 to 2 percent slopes	90	34	72	3.8	190
Whittier silt loam, 2 to 5 percent slopes	88	33	70	3.7	185
Whittier silt loam, 5 to 9 percent slopes, moderately eroded	80	30	64	3.4	170

[1] Animal-unit-days is the number of days that 1 acre will provide grazing for 1 animal unit, or 1,000 pounds of live weight, without damage to the pasture.

The yield predictions are meant to serve as guides. They are approximate values only and should be so considered. Of more value than actual yield figures to many users is the comparative yields between soils. Actual yields have been increasing in recent years, and if they continue to increase as expected, predicted yields in this table will soon be too low.

Woodland

Trees cover about 4 percent of Linn County, and most wooded areas are adjacent to the streams. Woodland was highly valued by the early settlers for building material and fuel. The settlers harvested the best trees and left the less desirable ones. Gradually the less desirable trees dominated the woodland. Some formerly wooded soils, notably the Chelsea, Lamont, Fayette, Seaton, and Coggon, were cleared for farming. Some of these soils are now eroded, and suitable trees should be planted on them.

The present pattern of tree cover is directly related to the nine soil associations in the county. The largest percentage of wooded areas is in associations 1 and 9. In the other soil associations, a few woodlots and trees are scattered along the drainageways, along fence rows, and on farmsteads.

Native woodland still in existence can be kept relatively productive with use of good management practices, such as protecting the areas from livestock and fire, group selective cutting, thinning and planting, and woodland weeding. The objective in woodland management is to attain sustained production by cutting the amount of wood that the stand is producing in yearly growth. This cutting can be done each year or periodically every 5 to 10 years. But some woodlands are of such poor quality that the best procedure is to replace the hardwoods with the relatively more valuable conifers. Before conifers are planted, competition from inferior species of trees and shrubs must be eliminated by mowing or by spraying them with some type of chemical brush killer.

Several agencies in Iowa can assist woodland owners in improving their products and marketing them. The Soil Conservation Service can help woodland owners determine which soils are suitable for trees and the production and conservation treatment needs of trees. State foresters can assist in developing plans for managing new or old stands of trees.

Factors affecting woodland management

Soils differ in their suitability for use as woodland. The factors that influence such use are somewhat different and

less restrictive than those that limit the use of soils for cultivated crops. This soil survey can help the owner of a wooded tract determine where he can get the best return for his investment in woodland management. If the soils are suited to trees, the owner can afford to spend time and money in managing his woodland carefully. Little management, other than that needed to protect the soils, however, is justified on poor sites. Some factors that are important in woodland management are discussed in the following paragraphs.

Moisture.—The growth of trees is directly related to the ability of a soil to supply moisture. The available water capacity of any soil depends largely on the slope, effective depth, texture, permeability, and internal drainage. Examples of soils that have only a limited supply of available moisture are the Chelsea, Sogn, and Sparta soils and Steep rock land.

Aspect, or direction of exposure.—Forest studies show a definite relationship between the exposure of a site and the rate of tree growth. Trees generally grow and produce better where slopes face north or east and on gently sloping or nearly level valley flats and broad ridgetops than in areas where slopes face south or west. Long, steep slopes that have various exposures are typical for such soils as the Fayette, Seaton, Sogn, and Steep rock land.

Erosion.—Eroded soils are generally not suitable for hardwoods, although pines can be planted on those sites. Examples of eroded soils are some soils of the Bassett, Coggon, Fayette, and Seaton series. Natural reseeding of trees is greatly reduced by erosion.

Soil reaction and soil fertility.—These factors have some influence on the adaptation and growth of different species of trees. For example, walnut and locust trees grow best on neutral to slightly calcareous soils. Pines need a slightly acid soil. Most species of pine, especially the native species, are poorly suited to soils that are high in lime, but hardwoods commonly grow well on those soils. Eastern redcedar is also tolerant to lime. Some areas of Seaton soils contain excess lime in the subsoil. Most of the bottom-land soils in Linn County are neutral in reaction. Hardwoods should not be planted on eroded or depleted soils, and they generally are poorly suited to formerly cultivated soils, whereas pines grow fairly well on these poorer sites.

Woodland suitability groups

Management of woodland can be planned more effectively if soils are grouped according to soil characteristics that affect the stands and growth of trees. In table 3, the soils of Linn County have been placed in 10 woodland suitability groups. Each group consists of soils that have about the same management limitations and potential productivity.

For each group, trees most suited to forest, windbreaks (fig. 9), and Christmas trees are listed. Also listed are trees and shrubs that are suitable as cover for wildlife. Some of the species listed provide food as well as cover.

Site index is the height in feet of the dominant and codominant trees in the stand at the age of 50 years (*10*). The estimates are based on data from well-stocked, even-aged stands that have good tree density and generally unmanaged stands. The site index is also a means of assessing site quality or potential productivity. Estimates are based on the experience and judgment of the woodland conservationist and soil scientists. Most of the wooded areas in the county are producing far below their potential. Better management than is now practiced will be required to attain the production shown.

Wildlife

In Linn County the trend toward larger farms and more intensive cropping systems has not only impaired the balance among the food, cover, and water that are needed for wildlife, but it has also destroyed entire habitats for wildlife. If the exploitation of land continues there is little hope for the preservation of wildlife and their habitats. It is the responsibility of the landowner to provide for the safety and preservation of the wildlife on his land.

Wildlife and their habitats are a necessary link in the cyclic chain of life processes. They are not only valuable from the standpoint of recreational, economic, and esthetic purposes but are necessary for the existence of man.

Any area can be utilized as a wildlife habitat, but various areas differ in their degree of suitability for specific habitats and wildlife. For example, the forested Fayette soils provide excellent habitat for such small upland animals as fox, squirrel, rabbits, groundhogs, and birds, but Fayette soils do not provide suitable habitat for such wetland wildlife as duck and muskrat.

Wildlife is influenced by topography and fertility and other characteristics of the soil. Topography affects wildlife through its influence on land use. The extremely rough, irregular areas such as those of Steep rock land, Loamy terrace escarpments, and the steep Fayette and Bassett soils may be hazardous for livestock and unsuitable for crops, but the undisturbed vegetation is valuable to wildlife. If suitable vegetation is lacking in some areas, it can often be developed to improve conditions for desirable kinds of wildlife.

Soil wetness and available water capacity are important considerations in selecting areas for construction of ponds for fish and for developing and maintaining habitats for wildlife. Some areas suited to wetland wildlife are Loamy alluvial land and Marsh. The Clyde, Colo, Floyd, Maxfield, and Tripoli soils are moderately suited to wetland wildlife habitat and also have few limitations for the construction of ponds. Ponds can also provide good recreational sites. Also, in areas of Loamy alluvial land are many small, undrained depressions that support marsh vegetation and hold water a part of the year, if not all the year. These areas are used by muskrat and mink, and also by migrating waterfowl for feeding and nesting. Mallard, teal, and other ducks nest and raise their young in these areas.

The Cedar and Wapsipinicon Rivers, Buffalo Creek, and smaller streams provide sport fishing.

The Fayette, Downs, and Chelsea soils have more wooded areas than the other soils in the county, and thereby give protection for fox, squirrel, deer, and many other animals. In as much as the cultivated areas are smaller than in other soils, there is enough protection for animals and also enough food from the crops that are grown by farmers.

In areas of the other soils, farms are larger and more intensively cropped. Fences have been removed so that large farm equipment can be used efficiently. The fence rows were formerly valuable as nesting places and travel

Figure 9.—**A windbreak of Douglas-fir that is 27 years old.**

lanes for some species of wildlife. They also provided a limited food supply. Although the food supply is abundant in the heavily cropped fields, a lack of cover nearby commonly makes the food unavailable. A year-round cover is needed to make the food easier to obtain. Quail, pheasant, and rabbit need this cover to escape from fox, hawks, and other predators. This cover also provides nesting places for game and songbirds. Some of the larger and more intensively cropped farms are on the Dinsdale, Kenyon, and Tama soils.

The district Soil Conservation Service office can provide complete information on creation and preservation of wildlife habitat.

Engineering Uses of the Soils

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4, 5, and 6, which show, respectively, several estimated soil properties significant to engineering; interpretations for various engineering uses; and results of engineering laboratory tests on soil samples.

This information, along with the soil map and other parts of this publication, can be used to make interpretations in addition to those given in tables 4 and 5, and it also can be used to make other useful maps.

This information, however, does not eliminate need for further investigations at sites selected for engineering

works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meanings to soil scientists that are not known to all engineers. The Glossary defines many of these terms as commonly used in soil science.

TABLE 3.—*Woodland interpretations*

[The symbol < means less than]

Description of woodland suitability groups, series, and map symbols	Estimated site index for upland oaks	Estimated board feet per acre per year for oaks	Species suitable for— Commercial open-land planting	Windbreaks	Wildlife
Group 1: Excessively drained and well-drained, coarse-textured and medium-textured soils that are shallow to sand, gravel, and bedrock; moderate to very rapid permeability; low or very low available moisture capacity. Burkhardt: 285C, 285D2. Loamy terrace escarpments: 154F. Sogn: 412C, 412D, 412G. Steep rock land: 478G.	<45	<100	Eastern white pine, Scotch pine, red pine, European larch, eastern redcedar, cottonwood.	Eastern white pine, Scotch pine, red pine, eastern red-cedar.	Honeysuckle, ninebark.
Group 2: Somewhat excessively drained or excessively drained, coarse-textured to medium-textured, nearly level to moderately steep soils; rapid or very rapid permeability; low or very low available moisture capacity. Chelsea: 63A, 63B, 63C, 63D, 63F. Chelsea-Lamont-Fayette: 293C, 293C2, 293D, 293D2, 293F, 293F2. Dickinson-Sparta-Tama: 442C, 442D. Flagler: 284A, 284B, 284C, 284C2. Sparta: 41A, 41B, 41C, 41D, 393B, 393C.	46–55	100–149	Eastern white pine, red pine, Scotch pine, European larch, eastern redcedar.	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry, honeysuckle.	Honeysuckle, viburnum, ninebark, lilac, dogwood, cardinal autumn-olive.
Group 3: Moderately coarse textured soils and medium-textured or moderately fine textured soils that have sand and gravel or bedrock at a depth of 20 to 40 inches; nearly level to moderately steep; moderate to moderately rapid permeability; low to moderate available moisture capacity. Bertram: 809B, 809C. Dickinson: 175A, 175B, 175C, 175D, 409B, 409C. Lamont: 110B, 110C. Olin: 408B, 408C. Rockton: 213B, 213C, 214B, 214C, 214D. Sattre: 778A, 778B, 778C2. Saude: 177A, 177B, 177C. Tell: 353B, 353C2. Wapsie: 777A, 777B. Waukee: 178A, 178B, 578A, 578B, 578C. Waukegan: 350A, 350B, 350C. Whalan: 207C2. Whittier: 352A, 352B, 352C2.	56–65	150–199	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, walnut, green ash, hackberry.	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry, honeysuckle.	Honeysuckle, viburnum, ninebark, lilac, dogwood, cardinal autumn-olive.

See footnote at end of table.

TABLE 3.—*Woodland interpretations*—Continued

Description of woodland suitability groups, series, and map symbols	Estimated site index for upland oaks	Estimated board feet per acre per year for oaks	Species suitable for— Commercial open-land planting	Windbreaks	Wildlife
Group 4: Well drained and moderately well drained, medium-textured or moderately fine textured, nearly level to moderately steep soils; moderate or moderately slow permeability; high or moderate available moisture capacity. Bertrand: 793A, 793B. Dinsdale: 377B, 377C, 377C2. Dodgeville: 204B, 204C. Downs: 162B, 162C, 162C2, 162D, 162D2. Fayette: 163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, T163B. Judson: 8B. Richwood: 977. Seaton: 663D, 633D2, 663E, 633E2. Tama: 120A, 120B, 120C, 120C2, T120A, T120B. Waubeek: 771B, 771C2.	76–85	250–300	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, walnut, green ash, hackberry, hard maple.	Eastern white pine, red pine, Norway spruce, white spruce, eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry.	Honeysuckle, viburnum, ninebark, lilac, dogwood, cardinal autumn-olive.
Group 5: Well drained and moderately well drained, medium-textured or moderately fine textured, steep or very steep soils; moderate permeability; high available moisture capacity. Fayette: 163F, 163F2. Seaton: 663F, 663F2.	66–75	200–249	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern redcedar, walnut, green ash, hackberry, hard maple.	Eastern white pine, red pine, Norway spruce, eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry.	Honeysuckle, viburnum, ninebark, lilac, dogwood, cardinal autumn-olive.
Group 6: Well drained and moderately well drained, medium-textured or moderately fine textured, nearly level to moderately steep soils, and soils that formed in moderately coarse textured or coarse textured material over medium-textured material; moderate to moderately slow permeability; high available moisture capacity. Aredale: 426A, 426B, 426C. Bassett: 171B, 171C, 171C2, 171D2, 171E2, 171F2. Coggon: 302C2. Kenyon: 83B, 83C, 83C2, 83D2.	66–75	200–249	Eastern white pine, white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, Douglas-fir, black walnut, green ash, hackberry.	Eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, Douglas-fir, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry.	Honeysuckle, ninebark, viburnum, lilac, dogwood, cardinal autumn-olive.
Group 7: Somewhat poorly drained, medium-textured or moderately fine textured, generally nearly level or gently sloping soils; slow runoff; moderate or moderately slow permeability, and moderate to high available moisture capacity for most soils; Donnan soils are gently sloping to moderately sloping and have very slow permeability; moderately deep phases of Hayfield and Lawler soils have low to moderate available moisture capacity. Atterberry: 291A, 291B, T291A, 351A. Donnan: 782B, 782C2. Ely: 428B. Floyd: 198B. Franklin: 761A, 761B. Hayfield: 725, 726. Klinger: 184A. Lawler: 225, 226. Muscatine: 119A, T119A. Nevin: 88. Oran: 471A, 471B. Readlyn: 399A. Schley: 407B. Stronghurst: 165A.	56–65	150–199	Eastern white pine, Scotch pine, red pine, Norway spruce, eastern redcedar, European larch, green ash, walnut, hackberry.	Eastern white pine, Scotch pine, red pine, Norway spruce, eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry, honeysuckle, red-osier dogwood.	Eastern white pine, Scotch pine, red pine, Norway spruce, eastern redcedar, Norway poplar, Siouxland poplar, robusta poplar, green ash, hackberry, honeysuckle, red-osier dogwood.

See footnote at end of table.

TABLE 3.—*Woodland interpretations*—Continued

Description of woodland suitability groups, series, and map symbols	Estimated site index for upland oaks	Estimated board feet per acre per year for oaks	Species suitable for— Commercial open-land planting	Windbreaks	Wildlife
Group 8: Dominantly well-drained to somewhat poorly drained, moderately coarse textured to moderately fine textured, nearly level or gently sloping soils on bottom lands; slow to medium runoff; moderate or moderately rapid permeability; high available moisture capacity for most soils, but ranges to low or very low in fine sandy loams and loamy fine sands. Kennebec: 212. Lawson: 484. Loamy alluvial land: 315. Nodaway: 220A, 220B. Spillville: 485.	(1)	(1)	(1)	Cottonwood, soft maple, green ash.	(1).
Group 9: Poorly drained, medium-textured to fine-textured, nearly level or gently sloping soils; moderate to very slow permeability; high or moderate available moisture capacity. Clyde: 84. Clyde-Floyd-Schley: 391B. Colo: 133, 133+. Colo-Ely: 11B. Donnan: 772. Garwin: 118. Klinger-Maxfield: 381B. Marshan: 151, 152. Maxfield: 382. Tripoli: 398. Walford: 160, T160.	(1)	(1)	Soft maple, cottonwood, sycamore, willow, green ash, hackberry.	Soft maple, cottonwood, sycamore, willow, green ash, hackberry.	Soft maple, cottonwood, sycamore, willow, green ash, hackberry.
Group 10: Very poorly drained organic soils Marsh: 354. Muck: 21, 221.	(1)	(1)	(1)	(1)	Red-osier dogwood, buttonball bush.

[1] Soils generally not suited.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*18*), used by the SCS engineers, Department of Defense, and others, and the AASHO (*1*) system, adopted by the American Association of State Highway Officials.

In the Unified system soils are classified according to particle size distribution, plasticity, liquid limit, and organic matter. Soils are grouped in 15 classes. There are eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH: and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A-1 is gravelly soil of high bearing strength, or the best soil for subgrade (foundation). At the other extreme, in group A-7, is clay soil that has low strength when wet and that is the poorest soil for subgrade. Where laboratory data are available to justify a further breakdown, the A-1, A-2, and A-7 groups are divided as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils is shown in table 6; the estimated classification is given in table 4 for all soils mapped in the survey area.

Soil properties significant to engineering

Several soil properties significant to engineering are estimated in table 4. These estimates are made for typical soil profiles, by layers sufficiently different to have different significance for soil engineering. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kind of soil in other countries. Following are explanations of some of the columns in table 4.

Depth to bedrock is distance from the surface of the soil to the upper surface of the rock layer.

Depth to seasonal high water table is distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 4 in the standard terms used by the Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2 millimeters in

diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Permeability is that quality of a soil that enables it to transmit water or air. It is estimated on the basis of those soil characteristics observed in the field, particularly structure and texture. The estimates in table 4 do not take into account lateral seepage or such transient soil features as plowpans and surface crusts.

Available water capacity is the ability of soils to hold water for use by most plants. It is commonly defined as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most crop plants.

Reaction is the degree of acidity or alkalinity of a soil, expressed in pH values. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential is the relative change in volume to be expected of soil material with changes in moisture content, that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. Extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils causes much damage to building foundations, roads, and other structures. A *high* shrink-swell potential indicates a hazard to maintenance of structures built in, on, or with material having this rating.

Engineering interpretations of the soils

The interpretations in table 5 are based on the engineering properties of soils shown in table 4, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Linn County. In table 5, ratings are used to summarize limitations or suitability of the soil for all listed purposes other than for highway location, foundations for low buildings, reservoir areas, embankments, drainage of cropland and pasture, terraces and diversions, and grassed waterways. For these particular uses, table 5 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings slight, moderate, and severe. *Slight* means that the soil properties generally are favorable for the rated use, or that limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that the soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation and special design. For some uses, the rating of severe is divided to obtain ratings of severe and very severe. *Very severe* means one or more soil properties are so unfavorable for a particular use that overcoming the limitations is most difficult and costly and commonly is not practical for the rated use.

Soil suitability is rated by the terms *good*, *fair*, and *poor*, which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Following are explanations of some of the columns in table 5:

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, such as in preparing a seedbed; natural fertility of the material, or its response of plants when fertilizer is applied; and absence of substances toxic to plants. Texture of the soil material and content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 5 provide guidance about where to look for probable sources. A soil rated as a *good* or *fair* source of sand or gravel generally has a layer at least 3 feet thick, the top of which is at a depth of less than 6 feet. The ratings do not take into account thickness of overburden, location of the water table, or factors that affect mining of the materials, and neither do they indicate quality of the deposit.

Road fill is soil material used in embankments for roads. The suitability ratings reflect the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and the relative ease of excavating the material at borrow areas.

Highway location, as rated in table 5, refers to sites for highways that have an all-weather surface expected to carry automobile traffic all year. The highways have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These locations are graded to shed water and have ordinary provisions for drainage. They are built from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of highways are load-supporting capacity and stability of the subgrade, and the workability and quantity of cut and fill material available. The AASHO and Unified classification of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Foundations for low buildings, as rated in table 5, are for buildings not more than three stories high that are supported by footings placed in undisturbed soil. The features that affect the rating of a soil are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

TABLE 4.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils for referring to other series that appear in the first column of thi:

Soil name and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
	Ft.	*Ft.*	*In.*			
Aredale: 426A, 426B, 426C	>10	>5	0–19	Loam	CL	A-4(4-8)
			19–33	Light clay loam and heavy loam.	CL, SM	A-4(1-4) or A-6 (4-8)
			33–55	Sandy loam	SM or SC	A-2-4 or A-4(1-4)
			55–70	Heavy loam	CL	A-6(6-10)
Atterberry: 291A, 291B	>10	2–4	0–16	Silt loam	ML or CL	A-6(8-12)
			16–46	Silty clay loam	CL	A-7-6(12-16)
			46–60	Heavy silt loam	CL	A-6(8-12) or A-7-6 (10-14)
T291A	>10	2–4	0–17	Silt loam	ML or CL	A-6(8-12)
			17–42	Silty clay loam	CL	A-7-6(12-16)
			42–50	Heavy silt loam	ML or CL	A-6(8-12) or A-7-6 (10-14)
			50–60	Sandy loam	SM or SC	A-4(1-5) or A-2-4
351A	>10	2–4	0–18	Silt loam	ML or CL	A-6(8-12)
			18–33	Silty clay loam	CL	A-7-6(12-16)
			33–43	Heavy silt loam	CL	A-6(8-12) or A-7-6 (10-14)
			43–55	Sand	SM or SP-SM	A-2-4 or A-3
Bassett: 171B, 171C, 171C2, 171D2, 171E2, 171F2.	>10	(²)	0–19	Loam	CL	A-4(4-8) or A-6 (6-10)
			19–39	Heavy loam	CL	A-6(6-10)
			39–60	Loam	CL	A-6(6-10)
Bertram: 809B, 809C	(³)	>5	0–30	Sandy loam	SM	A-4(1-4)
			30–34	Sandy clay loam	SC or CL	A-6(4-8)
			34	Limestone.		
Bertrand: 793A, 793B	>10	>5	0–11	Silt loam	ML or CL	A-4(4-8)
			11–45	Medium to heavy silt loam.	ML or CL	A-6(6-10)
			45–60	Stratified silt loam and coarse sandy loam.	ML and SM	A-4(4-8) and A-2-4
Burkhardt: 285C, 285D2	>10	>5	0–15	Sandy loam	SM	A-2-4 or A-4(1-4)
			15–60	Gravelly loamy sand and gravelly sand.	SW or SP	A-1-b
*Chelsea: 63A, 63B, 63C, 63D, 63F, 293C, 293C2, 293D, 293D2, 293F, 293F2. For properties of Fayette and Lamont soils in 293C, 293C2, 293D, 293D2, 293F, and 293F2, see their respective series.	>10	>5	0–4	Loamy fine sand	SM	A-2-4
			4–70	Fine sand	SP or SM	A-3 or A-2
*Clyde: 84, 391B. For properties of Floyd and Schley soils in 391B, see their respective series.	>10	1–3	0–21	Silty clay loam	CL, OL, or OH	A-7-5 or A-7-6 (11-16)
			21–41	Heavy loam	CL, SM	A-6(6-10)
			41–60	Heavy loam	CL, SM	A-6(6-10)
Coggon: 302C2	>10	(²)	0–14	Loam	CL or ML	A-4(4-8) or A-6 (6-10)
			14–60	Heavy loam	CL	A-6(6-10)

See footnotes at end of table.

significant to engineering

in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions table. The sign > means more than; the sign < means less than]

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
			In./hr.	In./in. of soil	pH	
100	100	60–75	0.63–2.00	0.15–0.18	5.1–6.0	Moderate.
100	100	40–70	0.63–2.00	0.14–0.18	5.1–6.0	Moderate.
100	100	30–40	2.00–6.30	0.10–0.14	5.6–6.0	Low.
95–100	80–100	55–65	0.63–2.00	0.14–0.17	5.6–6.0	Moderate.
100	100	95–100	0.63–2.00	0.19–0.23	5.6–7.3	Moderate.
100	100	95–100	0.20–6.30	0.19–0.21	5.1–6.0	Moderate to high.
100	100	95–100	0.63–2.00	0.18–0.20	5.6–6.0	Moderate.
100	100	95–100	0.63–2.00	0.19–0.23	5.6–7.3	Moderate.
100	100	95–100	0.20–6.30	0.19–0.21	5.1–6.0	Moderate to high.
100	100	95–100	0.63–2.00	0.18–0.20	5.6–6.0	Moderate.
100	100	30–40	2.00–6.30	0.10–0.14	5.6–6.0	Low.
100	100	95–100	0.63–2.00	0.19–0.23	5.6–7.3	Moderate.
100	100	95–100	0.63–2.00	0.19–0.21	5.6–6.0	Moderate to high.
100	100	95–100	0.63–2.00	0.18–0.20	5.6–6.0	Moderate.
100	80–100	5–25	6.30–20.0	0.02–0.04	5.6–6.0	Very low.
100	100	65–80	0.63–2.00	0.14–0.18	4.5–6.5	Moderate.
95–100	90–95	55–65	0.20–0.63	0.14–0.17	4.5–5.5	Moderate.
95–100	90–95	55–65	0.20–0.63	0.14–0.17	6.6–7.8	Moderate.
100	95–100	36–50	2.00–6.30	0.10–0.14	5.6–7.3	Low.
100	100	35–55	0.63–2.00	0.14–0.18	5.6–6.0	Low to moderate.
100	100	90–100	0.63–2.00	0.18–0.23	6.1–7.3	Moderate.
100	100	90–100	0.63–2.00	0.18–0.23	5.1–6.1	Moderate.
95–100	90–100	30–90	0.63–6.30	0.10–0.20	5.1–5.5	Moderate to low.
90–100	90–95	25–40	2.00–6.30	0.10–0.14	5.1–5.5	Low.
70–90	40–60	3–10	6.30–20.0	0.02–0.04	5.6–6.0	Very low.
100	95–100	10–30	6.30–20.0	0.06–0.08	5.1–6.5	Low.
100	95–100	8–20	6.30–20.0+	0.02–0.04	5.1–5.5	Very low.
100	95–100	70–90	0.63–2.00	0.19–0.21	6.6–7.3	High.
95–100	90–100	45–65	0.63–2.00	0.15–0.18	6.6–7.3	Moderate.
95–100	90–100	45–65	0.20–0.63	0.14–0.18	6.6–7.3	Moderate.
100	95–100	65–75	0.63–2.00	0.14–0.18	5.6–6.5	Moderate.
95–100	90–95	50–65	0.20–0.63	0.14–0.17	5.1–5.5	Moderate.

TABLE 4.—*Estimated soil properties*

Soil name and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
*Colo:						
11B, 133	>10	1–3	0–45	Medium silty clay loam.	OH or CH	A-7-6(17-20)
For properties of the Ely soils in 11B, see the Ely series.			45–61	Light silty clay loam	CH or CL	A-7-6(12-16)
133+	>10	1–3	0–17	Silt loam	CL or ML	A-4(4-8) or A-6 (8-12)
			17–60	Silty clay loam	OH or CH	A-7-6(17-20)
*Dickinson:						
175A, 175B, 175C, 175D, 442C, 442D.	>10	>5	0–33	Fine sandy loam and sandy loam.	SM or ML	A-4(1-5)
For properties of the Sparta and Tama soils in 442C and 442D, see their respective series.			33–78	Loamy fine sand to fine sand.	SM or SP-SM	A-2-4 or A-3
409B, 409C	>10	(4)	0–45	Fine sandy loam	SM or ML	A-4(1-5)
			45–70	Heavy loam	CL	A-6(6-10)
Dinsdale: 377B, 377C, 377C2	>10	>5	0–14	Light silty clay loam	ML or CL	A-6(8-12)
			14–27	Medium silty clay loam.	CL	A-6(10-12) or A-7-6(12-14)
			27–48	Loam	CL	A-6(8-12)
			48–60	Sandy clay loam	CL or SC	A-6(3-10)
Dodgeville: 204B, 204C	(5)	>5	0–8	Heavy silt loam	ML or CL	A-4(4-8) or A-6(6-10)
			8–34	Light to medium silty clay loam.	CL	A-7-6(11-14)
			34–37	Silty clay	CH	A-7-6(20)
			37	Limestone.		
Donnan:						
782B, 782C2	>10	(7)	0–12	Loam	CL	A-6(8-12)
			12–26	Clay loam and gritty silty clay loam.	CL	A-6(8-12)
			26–78	Clay	CH	A-7-6(20)
772	>10	(8)	0–14	Loam	CL or ML	A-4(4-8)
			14–27	Silty clay loam and light clay loam.	CL	A-6(8-12)
			27–39	Clay	CH	A-7-6(20)
			39–60	Clay loam	CL	A-6(6-12)
Downs: 162B, 162C, 162C2, 162D, 162D2.	>10	>5	0–15	Silt loam	ML or CL	A-4(4-8) or A-6(6-10)
			15–45	Light silty clay loam	CL	A-7-6(10-14)
			45–60	Silt loam	CL	A-6(8-10) or A-7-6(10-14)
Ely: 428B	>10	2–3	0–7	Silt loam	ML or CL	A-6(8-12) or A-7-6(12-14)
			7–71	Light silty clay loam	CL	A-7-6(12-16)

See footnotes at end of table.

significant to engineering—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
			In./hr.	*In./in. of soil*	*pH*	
100	100	95–100	0. 20–0. 63	0. 19–0. 21	6. 6–7. 3	High.
100	100	95–100	0. 20–0. 63	0. 18–0. 20	6. 6–7. 3	High.
100	100	85–100	0. 63–2. 00	0. 18–0. 23	6. 6–7. 3	Moderate to high.
100	100	95–100	0. 20–0. 63	0. 19–0. 21	6. 6–7. 3	High.
100	100	35–60	2. 00–6. 30	0. 11–0. 16	5. 6–7. 3	Low.
100	100	5–20	6. 30–20. 0	0. 03–0. 06	5. 6–6. 0	Very low.
100	100	35–60	2. 00–6. 30	0. 11–0. 16	5. 6–7. 3	Low.
95–100	90–95	45–65	0. 20–0. 63	0. 14–0. 18	6. 6–7. 8	Moderate.
100	100	90–100	0. 63–2. 00	0. 19–0. 22	6. 1–7. 3	Moderate.
100	100	80–95	0. 63–2. 00	0. 19–0. 21	5. 6–6. 0	Moderate to high.
95–100	90–95	55–75	0. 20–0. 63	0. 16–0. 18	5. 6–6. 0	Moderate.
95–100	90–95	35–55	0. 20–0. 63	0. 14–0. 18	6. 1–6. 5	Moderate.
100	100	95–100	0. 63–2. 00	0. 19–0. 22	6. 6–7. 3	Moderate.
100	100	90–100	0. 63–2. 00	0. 19–0. 21	5. 1–6. 0	Moderate to high.
65–100	80–100	70–95	<0. 06	0. 15–0. 18	6. 1–6. 5	High.
100	100	65–75	0. 63–2. 00	0. 14–0. 18	6. 6–7. 3	Moderate.
100	90–100	60–70	0. 20–0. 63	0. 16–0. 19	5. 1–6. 0	Moderate.
95–100	85–100	70–90	<0. 06	0. 15–0. 18	6. 1–6. 5	High.
100	100	65–85	0. 63–2. 00	0. 14–0. 18	5. 6–7. 3	Moderate.
100	90–100	60–70	0. 20–0. 63	0. 16–0. 19	5. 6–6. 0	Moderate.
95–100	85–100	70–90	<0. 06	0. 15–0. 18	5. 6–6. 0	High.
95–100	85–100	60–70	0. 20–0. 63	0. 16–0. 18	5. 6–6. 0	Moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 21	6. 1–6. 5	Moderate.
100	100	95–100	0. 63–2. 00	0. 16–0. 18	5. 1–5. 5	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 16–0. 18	5. 6–6. 0	Moderate.
100	100	90–100	0. 63–2. 00	0. 19–0. 23	6. 6–7. 3	Moderate.
100	100	90–100	0. 63–2. 00	0. 19–0. 21	6. 1–7. 3	Moderate to high.

TABLE 4.—*Estimated soil properties*

Soil name and map symbols	Depth to— Bedrock	Seasonal high water table	Depth from surface	Classification USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Fayette:						
163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, 163F, 163F2.	>10	>5	0–12	Silt loam	ML or CL	A-4(4-8)
			12–48	Heavy silt loam and medium silty clay loam.	CL	A-7-6(12-15)
			48–70	Silt loam	CL	A-6(8-10) or A-7-6(12-14)
T163B	>10	>5	0–9	Silt loam	ML or CL	A-4(4-8)
			9–38	Silty clay loam	CL	A-7-6(12-15)
			38–50	Silt loam	CL	A-6(8-10) or A-7-6(12-14)
			50–60	Sandy loam and loamy sand.	SM	A-2-4 or A-4(0-2)
Flagler: 284A, 284B, 284C, 284C2.	>10	>5	0–19	Sandy loam	SM	A-2 or A-4
			19–40	Coarse sandy loam and coarse loamy sand with some gravel.	SM or SP, SW-SM	A-1-a
			40–60	Sand with some gravel.	SW or SW-SM	A-1-a
Floyd: 198B	>10	2–4	0–30	Loam and heavy loam	OH or OL	A-7-5 (10-15)
			30–40	Sandy loam	SC or SM	A-2-4 or A-4 (1-4)
			40–63	Heavy loam	CL or SC	A-6 (3-12)
Franklin: 761A, 761B	>10	2–4	0–13	Silt loam	ML or CL	A-4 (4-8)
			13–28	Silty clay loam	CL	A-7-6 (12-16)
			28–64	Heavy loam	CL	A-6 (8-12)
			64–74	Loam	CL or SC	A-6 (6-10)
Garwin: 118	>10	1–3	0–22	Light to medium silty clay loam.	CH or OH	A-7-5 (14-18) or A-7-6 (15-19)
			22–36	Medium silty clay loam.	CH or CL	A-7-6 (15-18)
			36–60	Heavy silt loam	CL	A-6 (10-12) or A-7-6 (12-14)
Hayfield:						
725	>10	2–4	0–15	Loam	CL	A-6 (4-8)
			15–26	Loam	CL	A-6 (4-8)
			26–43	Loamy sand with gravel.	SM or SP-SM	A-1-b or A-2-4
726	>10	2–4	0–7	Loam	CL	A-6 (4-8)
			7–16	Gritty silt loam	CL	A-6 (8-12)
			16–36	Loam	CL	A-6 (6-10)
			36–60	Loamy sand with gravel.	SM or SP-SM	A-1-b or A-2-4
Judson: 8B	>10	>5	0–30	Light silty clay loam	CL or OL	A-6 (8-10) or A-7-6 (12-14)
			30–54	Medium silty clay loam to light silty clay loam.	CL	A-6 (10-12) or A-7-6 (12-14)
			54–65	Heavy silt loam	CL	A-6 (6-10)
Kennebec: 212	>10	3–5	0–43	Silt loam to light silty clay loam.	OL or CL	A-6(8-12) or A-7-6(10-14)
			43–58	Sandy loam	SC	A-4(2-6)
			58–72	Heavy loam	CL	A-6(4-8)

significant to engineering—Continued

Percentage passing sieve— No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
			In./hr.	*In./in. of soil*	*pH*	
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 6–6. 5	Moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 1–6. 0	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 1–5. 5	Moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 23	5. 6–6. 5	Moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 1–6. 0	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 1–5. 5	Moderate.
95–100	80–100	15–45	2. 00–6. 30	0. 10–0. 14	5. 6–6. 0	Low.
90–100	90–95	25–40	2. 00–6. 30	0. 10–0. 14	5. 1–6. 0	Low.
70–90	40–60	3–15	6. 30–20. 0	0. 04–0. 06	5. 1–6. 0	Very low.
70–90	40–60	3–10	>20. 0	0. 02–0. 04	5. 6–6. 0	Very low.
100	100	70–85	0. 63–2. 00	0. 18–0. 22	6. 1–7. 3	Moderate to high.
80–100	75–95	20–50	2. 00–6. 30	0. 10–0. 14	6. 6–7. 3	Low to moderate.
95–100	95–100	45–65	0. 20–0. 63	0. 14–0. 18	6. 6–7. 3	Moderate.
100	100	95–100	0. 63–2. 00	0. 19–0. 23	5. 1–7. 3	Moderate.
100	100	95–100	0. 63–2. 00	0. 19–0. 21	5. 1–6. 0	Moderate to high.
95–100	90–95	55–75	0. 20–0. 63	0. 16–0. 18	5. 6–6. 0	Moderate.
95–100	90–95	45–65	0. 20–0. 63	0. 16–0. 18	6. 6–7. 8	Moderate.
100	100	95–100	0. 20–0. 63	0. 20–0. 22	6. 1–7. 3	High.
100	100	95–100	0. 20–0. 63	0. 19–0. 21	6. 1–7. 3	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 18–0. 23	6. 6–7. 3	Moderate.
95–100	95–100	60–80	0. 63–2. 00	0. 15–0. 19	6. 1–6. 5	Moderate.
95–100	95–100	60–80	0. 63–2. 00	0. 14–0. 18	5. 1–5. 5	Moderate.
80–95	70–90	3–15	6. 30–20. 0+	0. 02–0. 04	5. 1–5. 5	Very low.
95–100	95–100	60–80	0. 63–2. 00	0. 15–0. 19	6. 6–7. 3	Moderate.
95–100	95–100	60–80	0. 63–2. 00	0. 14–0. 18	5. 1–7. 3	Moderate.
95–100	90–95	50–75	0. 63–2. 00	0. 14–0. 17	5. 6–6. 0	Moderate.
80–95	70–90	3–15	6. 30–20. 0+	0. 02–0. 04	5. 1–5. 5	Very low.
100	100	90–100	0. 63–2. 00	0. 20–0. 22	5. 6–6. 5	Moderate.
100	100	90–100	0. 63–2. 00	0. 19–0. 21	5. 6–6. 0	Moderate.
100	100	90–100	0. 63–2. 00	0. 18–0. 21	5. 6–6. 0	Moderate.
100	100	95–100	0. 63–2. 00	0. 19–0. 21	6. 6–7. 3	Moderate to high.
100	100	40–50	0. 63–2. 00	0. 10–0. 14	6. 6–7. 3	Low to moderate.
100	100	70–85	0. 63–2. 00	0. 14–0. 18	6. 6–7. 3	Moderate.

TABLE 4.—*Estimated soil properties*

Soil name and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Kenyon: 83B, 83C, 83C2, 83D2	>10	(2)	0–17	Loam	CL or OL	A–6(6–10)
			17–52	Heavy loam	CL	A–6(6–10)
			52–67	Heavy loam	CL	A–6(6–10)
*Klinger: 184A, 381B. For properties of the Maxfield soil in 381B, see the Maxfield series.	>10	2–4	0–19	Light silty clay loam	ML or CL	A–7–6(10–14)
			19–33	Medium silty clay loam	CL	A–7–6(12–16)
			33–45	Heavy loam	CL or SC	A–6(6–10)
			45–60	Heavy loam	CL or SC	A–6(6–10)
Lamont: 110B, 110C	>10	>5	0–13	Fine sandy loam and sandy loam.	SM or SC	A–4(1–4)
			13–28	Sandy loam	SC or SM	A–4(1–4)
			28–60	Loamy sand and sand	SM or SP–SM	A–2–4 or A–3
Lawler:						
225	>10	2–4	0–14	Heavy loam	CL or OL	A–6(6–10) or A–7–5(8–12)
			14–24	Heavy loam	CL	A–6(6–12)
			24–36	Gravelly sandy loam and gravelly loamy sand.	SM to SP–SM	A–1–b or A–2–4
226	>10	2–4	0–17	Loam	CL or OL	A–6(6–10) or A–7–5(8–12)
			17–38	Loam	CL	A–6(8–12)
			38–50	Loamy sand with some gravel.	SP–SM	A–1–b or A–2–4
Lawson: 484	>10	3–5	0–32	Silt loam	ML or OL	A–6(8–12) or A–7–5(10–15)
			32–60	Silt loam	CL	A–6(8–12)
Loamy alluvial land: 315. Properties too variable to be estimated.						
Loamy terrace escarpments: 154F. Properties too variable to be estimated.						
Marsh: 354. Properties too variable to be estimated.						
Marshan:						
151	>10	1–3	0–17	Gritty silty clay loam	OL or OH	A–7–5(11–18)
			17–31	Gritty silty clay loam	CL	A–7–6(8–12)
			31–58	Medium sand and mixed fine gravel.	SM or SP–SM	A–1–b or A–2–4
152	>10	1–3	0–15	Silty clay loam	OL or OH	A–7–5(10–15)
			15–40	Gritty medium silty clay loam.	CL	A–6(6–10) or A–7–6(8–12)
			40–47	Loam	CL	A–6(4–8)
			47–65	Coarse loamy sand and coarse sand.	SM, SP–SW	A–1–b or A–2–4
Maxfield: 382	>10	1–3	0–17	Light silty clay loam	CH or OH	A–7–5(14–18)
			17–34	Light silty clay loam	CL or CH	A–7–6(14–18)
			34–60	Loam	CL	A–6(6–10)
Muck:						
21	>10	0–1	0–15	Muck	Pt	Muck
			15–42	Silty clay loam	CL	A–7–6(12–16)
221	>10	0–1	0–38	Muck	Pt	Muck
			38–55	Sandy loam	SC	A–2–4 or A–4(1–6)
			55–60	Silt loam	ML or CL	A–4(4–8) or A–6(6–10)

See footnotes at end of table.

significant to engineering—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
			In./hr.	*In./in. of soil*	*pH*	
100	95-100	60-80	0.63-2.00	0.17-0.19	5.6-7.3	Moderate.
95-100	85-95	45-65	0.20-0.63	0.15-0.18	5.1-6.0	Moderate.
95-100	85-95	45-65	0.20-0.63	0.15-0.18	6.6-7.3	Moderate.
100	100	95-100	0.20-0.63	0.20-0.22	5.6-6.0	Moderate to high.
100	100	95-100	0.20-0.63	0.19-0.21	6.1-6.5	Moderate to high.
95-100	90-100	45-65	0.20-0.63	0.16-0.18	6.1-6.5	Moderate.
95-100	90-100	45-65	0.20-0.63	0.16-0.18	6.6-7.3	Moderate.
100	100	25-50	2.00-6.30	0.10-0.16	5.6-6.5	Low.
100	100	30-50	2.00-6.30	0.10-0.14	5.1-6.0	Low.
100	100	5-20	6.30-20.0	0.02-0.06	5.6-6.0	Very low.
100	95-100	60-80	0.63-2.00	0.15-0.19	6.1-6.5	Moderate.
95-100	95-100	55-75	0.63-2.00	0.14-0.18	5.6-6.5	Moderate.
85-95	70-95	5-25	6.30-20.0+	0.02-0.04	5.6-6.0	Very low.
100	95-100	60-80	0.63-2.00	0.15-0.19	5.6-6.0	Moderate.
100	95-100	55-75	0.63-2.00	0.14-0.18	5.1-6.0	Moderate.
85-95	70-90	5-15	6.30-20.0+	0.02-0.04	5.6-6.6	Very low.
100	100	80-100	0.63-2.00	0.19-0.24	6.6-7.3	Moderate to high.
100	100	80-100	0.63-2.00	0.18-0.23	6.6-7.3	Moderate.
100	100	70-90	0.63-2.00	0.19-0.21	6.6-7.3	High.
95-100	90-100	55-75	0.63-2.00	0.19-0.21	6.6-7.3	High.
80-95	70-95	5-15	6.30-20.0	0.02-0.04	6.6-7.3	Very low.
100	100	70-90	0.63-2.00	0.20-0.22	6.6-7.3	High.
95-100	90-100	55-75	0.63-2.00	0.19-0.21	6.1-7.3	Moderate to high.
95-100	90-95	55-75	0.63-2.00	0.14-0.18	6.1-7.3	Moderate.
80-95	70-95	5-15	6.30-20.0	0.02-0.04	6.1-7.3	Very low.
100	100	95-100	0.63-2.00	0.20-0.22	6.6-7.3	High.
100	100	95-100	0.63-2.00	0.19-0.21	6.6-7.3	High.
95-100	90-95	55-75	0.20-0.63	0.14-0.18	6.6-8.4	Moderate.
100	100	95-100	2.00-6.30	0.20-0.25	6.6-7.3	Moderate.
100	100	90-100	0.20-0.63	0.19-0.21	6.6-7.3	Moderate to high.
100	100	95-100	2.00-6.30	0.20-0.25	6.6-7.3	Moderate.
100	75-95	20-50	2.00-6.30	0.10-0.14	6.6-7.3	Moderate.
100	100	85-95	0.63-2.00	0.18-0.23	6.6-7.3	Moderate.

TABLE 4.—*Estimated soil properties*

Soil name and map symbols	Depth to— Bedrock	Depth to— Seasonal high water table	Depth from surface	Classification — USDA texture	Classification — Unified	Classification — AASHO
	Ft.	*Ft.*	*In.*			
Muscatine:						
119A	>10	2–4	0–17	Light silty clay loam to heavy silt loam.	CL or OL	A-7-5(10-14) or A-7-6(11-14)
			17–40	Light to medium silty clay loam.	CL or CH	A-7-6(15-18)
			40–61	Heavy silt loam	CL	A-6(10-12) or A-7-6(12-14)
T119A	>10	2–4	0–19	Light silty clay loam	CL or OL	A-7-5(10-14) or A-7-6(11-14)
			19–42	Silty clay loam	CL or CH	A-7-6(15-18)
			42–55	Heavy silt loam	CL	A-6(10-12) or A-7-6(12-14)
			55–65	Loamy sand	SM	A-2-4
Nevin: 88	>10	2–4	0–23	Light silty clay loam	CL or OL	A-6(8-12) or A-7-6(10-14)
			23–39	Medium silty clay loam.	CL	A-7-6(14-18)
			39–58	Light silty clay loam	CL	A-6(8-10) or A-7-6(10-16)
Nodaway: 220A, 220B	>10	3–5	0–64	Silt loam	ML or CL	A-4(6-8) or A-6(10-12)
			64–69	Light silty clay loam	CL	A-6(8-10) or A-7-6(10-14)
Olin: 408B, 408C	>10	(7)	0–23	Fine sandy loam	SM or SC	A-2-4 or A-4(1-4)
			23–31	Sandy loam	SM or SP	A-2-4 or A-4(1-4)
			31–80	Heavy loam	CL or SC	A-6(6-10)
Oran: 471A, 471B	>10	2–4	0–23	Loam	CL	A-6(6-10)
			23–52	Medium and heavy loam.	CL	A-6(6-12)
			52–60	Heavy loam	CL	A-6(6-12)
Readlyn: 399A	>10	2–4	0–18	Loam	CL or OL	A-6(6-10)
			18–48	Heavy loam	CL	A-6(6-10)
			48–60	Heavy loam	CL	A-6(6-10)
Richwood: 977	>10	>5	0–20	Silt loam	ML or CL	A-4(4-8) or A-6(6-10)
			20–57	Silt loam	CL	A-7-6(10-14)
			57–64	Loam	CL	A-4(4-8) or A-6(6-10)
Rockton:						
213B, 213C	2½–3	>5	0–14	Medium and heavy loam.	CL	A-6(6-10)
			14–36	Clay loam	CL	A-6(8-12)
			36	Limestone.		
214B, 214C, 214D	1½–2½	>5	0–14	Loam	CL	A-6(6-10)
			14–22	Clay loam	CL	A-6(8-12)
			22	Limestone.		
Sattre: 778A, 778B, 778C2	>10	>5	0–19	Loam	CL	A-4(4-8)
			19–37	Loam and sandy loam	CL or SC	A-4(1-5) or A-6(4-8)
			37–62	Fine sand and loamy sand.	SP-SW or SM	A-1-b or A-2-4
Saude: 177A, 177B, 177C	>10	>5	0–18	Loam	CL	A-4(4-8) or A-6(6-10)
			18–35	Loam and sandy loam	CL or SC	A-4(1-5) and A-6(4-8)
			35–42	Gravelly loamy sand	SM, SP-SW	A-2-4 or A-1-b

See footnotes at end of table.

significant to engineering—Continued

Percentage passing sieve— No. 4 (4.7 mm.)	Percentage passing sieve— No. 10 (2.0 mm.)	Percentage passing sieve— No. 200 (0.074 mm.)	Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
			In./hr.	*In./in. of soil*	*pH*	
100	100	95-100	0.63-2.00	0.20-0.22	5.6-6.5	Moderate.
100	100	95-100	0.63-2.00	0.19-0.21	5.6-6.0	Moderate to high.
100	100	95-100	0.63-2.00	0.19-0.21	6.6-7.3	Moderate.
100	100	95-100	0.63-2.00	0.20-0.22	5.6-6.5	Moderate.
100	100	95-100	0.63-2.00	0.19-0.21	5.6-6.0	Moderate to high.
100	100	95-100	0.63-2.00	0.19-0.21	6.1-6.5	Moderate.
100	95-100	15-30	6.30-20.0	0.04-0.06	6.1-6.5	Very low.
100	95-100	90-100	0.63-2.00	0.20-0.22	6.6-7.3	Moderate to high.
100	95-100	80-100	0.20-2.00	0.19-0.21	6.1-7.3	High.
100	95-100	80-100	0.63-2.00	0.19-0.21	6.6-7.3	Moderate to high.
100	100	95-100	0.63-2.00	0.18-0.21	6.6-7.3	Moderate.
100	100	95-100	0.63-2.00	0.19-0.23	6.6-7.3	Moderate to high.
100	90-100	30-50	2.00-6.30	0.11-0.17	5.6-6.5	Low.
100	85-100	25-50	2.00-6.30	0.10-0.16	5.6-6.0	Low.
95-100	90-95	45-65	0.20-0.63	0.16-0.18	5.6-7.8	Moderate.
100	100	70-85	0.63-2.00	0.15-0.19	5.1-7.3	Moderate.
95-100	95-100	50-65	0.20-0.63	0.16-0.18	5.1-6.0	Moderate.
95-100	90-95	50-65	0.20-0.63	0.16-0.18	7.4-7.8	Moderate.
100	95-100	55-75	0.63-2.00	0.15-0.19	5.1-7.3	Moderate.
95-100	90-95	50-65	0.20-0.63	0.16-0.18	5.1-6.5	Moderate.
95-100	90-95	50-65	0.20-0.63	0.16-0.18	7.4-7.8	Moderate.
100	100	90-100	0.63-2.00	0.19-0.22	5.6-6.5	Moderate.
100	100	90-100	0.63-2.00	0.18-0.20	5.6-6.0	Moderate to high.
100	100	70-90	0.63-2.00	0.14-0.18	5.6-6.0	Moderate.
95-100	95-100	55-75	0.63-2.00	0.15-0.19	6.1-7.3	Moderate.
95-100	90-95	50-75	0.63-2.00	0.16-0.18	5.6-6.5	Moderate.
95-100	95-100	55-75	0.63-2.00	0.15-0.19	6.1-7.3	Moderate.
95-100	90-95	50-75	0.63-2.00	0.16-0.18	5.6-6.5	Moderate.
100	90-95	55-75	0.63-2.00	0.15-0.19	6.1-6.5	Moderate.
100	90-95	40-60	0.63-6.30	0.10-0.18	5.1-6.0	Moderate.
80-95	70-95	3-15	6.30-20.0+	0.02-0.04	5.1-5.5	Very low.
100	95-100	55-80	0.63-2.00	0.15-0.19	5.6-7.3	Moderate.
100	90-95	35-60	0.63-6.30	0.10-0.18	5.6-6.0	Low or moderate.
80-95	70-95	15-30	6.30-20.0+	0.02-0.04	5.6-6.0	Very low.

TABLE 4.—*Estimated soil properties*

Soil name and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Schley: 407B	>10	2-4	0-12	Loam	CL	A-4(4-8) or A-6(6-10)
			12-23	Heavy loam	CL or SC	A-6(6-10)
			23-48	Heavy sandy loam	CL or SC	A-4(1-5) or A-2-4
			48-55	Loam	CL or SC	A-6(4-8)
Seaton: 663D, 663D2, 663E, 663E2, 663F, 663F2.	>10	>5	0-6	Silt loam	ML	A-4(4-8)
			6-41	Silt loam	CL	A-6(8-10)
			41-70	Silt loam	ML or CL	A-4(4-8)
Sogn: 412C, 412D, 412G	<1½	>5	0-10	Loam	CL	A-6(4-8)
			10	Limestone.		
Sparta:						
41A, 41B, 41C, 41D	>10	>5	0-19	Loamy fine sand	SM	A-2-4
			19-72	Loamy fine sand to fine sand.	SM or SP-SM	A-2-4 or A-3
393B, 393C	>10	>5	0-32	Loamy fine sand	SM	A-2-4
			32-41	Sand	SM or SP-SM	A-2-4 or A-3
			41-56	Light and heavy loam	CL	A-6(6-10)
Spillville: 485	>10	2-4	0-53	Loam	OL or CL	A-4(2-6) or A-6(4-8)
			53-60	Light loam	CL or SM	A-4(2-6) or A-2-4
Steep rock land: 478G	<1	>10				
Stronghurst: 165A	>10	2-4	0-12	Silt loam	ML or CL	A-4(4-8)
			12-45	Silty clay loam	CL	A-7-6(10-14)
			45-55	Heavy silt loam	CL	A-6(6-10) or A-7-6(10-14)
Tama:						
120A, 120B, 120C, 120C2	>10	>5	0-16	Light silty clay loam	ML or CL	A-6(8-10) or A-7-6(10-14)
			16-63	Light silty clay loam and medium silty clay loam.	CL	A-7-6(12-16)
			63-83	Heavy silt loam	CL	A-6(8-12)
T120A, T120B	>10	>5	0-17	Light silty clay loam	ML or CL	A-6(8-10) or A-7-6(10-14)
			17-44	Light and medium silty clay loam.	CL	A-7-6(12-16)
			44-55	Heavy silt loam	CL	A-6(8-12)
			55-70	Loamy sand and fine sand.	SM or SP-SM	A-2-4 or A-3
Tell: 353B, 353C2	>10	>5	0-12	Silt loam	CL or ML	A-4(4-8)
			12-25	Silty clay loam	CL	A-7-6(10-14)
			25-32	Heavy loam	CL	A-6(6-10)
			32-72	Loamy sand and fine sand.	SM or SP-SM	A-2-4 or A-3
Tripoli: 398	>10	1-3	0-14	Gritty silty clay loam	CL or OH	A-7-6(10-14) or A-7-5(12-16)
			14-27	Clay loam	CL	A-6(8-12)
			27-64	Heavy loam and sandy clay loam.	CL	A-6(6-12)

significant to engineering—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
			In./hr.	*In./in. of soil*	*pH*	
100	100	70–85	0. 63–2. 00	0. 15–0. 19	6. 6–7. 3	Moderate.
95–100	90–95	40–65	0. 63–2. 00	0. 16–0. 18	5. 1–5. 5	Moderate.
90–95	90–95	30–65	2. 00–6. 30	0. 10–0. 18	5. 1–6. 5	Low to moderate.
95–100	90–95	45–65	0. 20–0. 63	0. 16–0. 18	6. 6–7. 3	Moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 23	6. 6–7. 3	Low.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 6–7. 3	Low to moderate.
100	100	90–100	0. 63–2. 00	0. 18–0. 20	5. 6–6. 0	Low.
75–100	70–90	55–75	0. 63–2. 00	0. 15–0. 19	7. 4–7. 8	Moderate.
100	100	15–30	6. 30–20. 0+	0. 06–0. 08	5. 6–6. 0	Very low.
100	100	5–20	6. 30–20. 0+	0. 04–0. 08	5. 6–6. 0	Very low.
100	100	15–30	6. 30–20. 0+	0. 06–0. 08	5. 6–6. 0	Very low.
100	100	5–20	6. 30–20. 0+	0. 02–0. 04	5. 6–6. 0	Very low.
95–100	90–95	50–65	0. 20–0. 63	0. 16–0. 18	5. 1–5. 5	Moderate.
100	100	70–85	0. 63–2. 00	0. 15–0. 19	5. 6–7. 3	Moderate.
100	95–100	20–60	0. 63–2. 00	0. 14–0. 18	6. 6–7. 3	Moderate to low.
100	100	95–100	0. 63–2. 00	0. 18–0. 21	6. 6–7. 3	Low to moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 1–6. 0	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 6–6. 0	Moderate.
100	100	95–100	0. 63–2. 00	0. 20–0. 23	6. 1–6. 5	Moderate.
100	100	95–100	0. 20–0. 63	0. 19–0. 21	5. 6–6. 0	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 19–0. 21	5. 6–6. 0	Moderate.
100	100	95–100	0. 63–2. 00	0. 20–0. 23	6. 1–7. 3	Moderate.
100	100	95–100	0. 20–0. 63	0. 19–0. 21	5. 6–6. 0	Moderate to high.
100	100	95–100	0. 63–2. 00	0. 19–0. 21	5. 6–6. 0	Moderate.
100	90–100	5–20	6. 30–20. 0+	0. 02–0. 06	6. 1–7. 3	Very low.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	6. 6–7. 3	Moderate.
100	100	95–100	0. 63–2. 00	0. 17–0. 19	6. 1–6. 5	Moderate to high.
100	90–100	55–70	0. 63–2. 00	0. 14–0. 18	5. 6–6. 0	Moderate.
100	90–100	5–20	6. 30–20. 0+	0. 02–0. 06	6. 1–7. 3	Very low.
100	100	80–90	0. 63–2. 00	0. 20–0. 22	6. 6–7. 3	High.
100	100	75–85	0. 20–0. 63	0. 16–0. 18	6. 6–7. 3	Moderate.
95–100	90–95	50–70	0. 20–0. 63	0. 14–0. 18	6. 6–7. 8	Moderate.

TABLE 4.—*Estimated soil properties*

Soil name and map symbols	Depth to—		Depth from surface	Classification		
	Bedrock	Seasonal high water table		USDA texture	Unified	AASHO
	Ft.	*Ft.*	*In.*			
Walford:						
160	>10	0–3	0–20	Silt loam	ML or CL	A-4(4–8)
			20–65	Heavy silt loam and silty clay loam.	CH or CL	A-7-6(14–18)
T160	>10	0–3	0–17	Silt loam	ML or CL	A-4(4–8)
			17–49	Silty clay loam	CL or CH	A-7-6(12–18)
			49–60	Heavy silt loam	CL	A-7-6(10–14)
			60–72	Loamy sand	SM or SP-SM	A-2-4
Wapsie: 777A, 777B	>10	>5	0–23	Loam	CL	A-4(4–8)
			23–28	Sandy loam	SC or CL	A-4(1–5)
			28–60	Fine and medium sand.	SM or SP-SM	A-2-4
Waubeek: 771B, 771C2	>10	>5	0–10	Silt loam	ML or CL	A-4(4–8)
			10–26	Silty clay loam	CL	A-7-6(10–14)
			26–72	Sandy clay loam and loam.	CL or SC	A-6(6–10)
Waukee:						
178A, 178B	>10	>5	0–23	Loam	CL or OL	A-6(6–10)
			23–38	Loam and heavy fine sandy loam.	CL or SC	A-6(4–8)
			38–55	Loamy sand to medium sand with some gravel.	SM or SP-SM or SP	A-2-4 or A-1-b
578A, 578B, 578C	>10	>5	0–21	Loam	CL	A-6(6–10)
			21–36	Loam	CL	A-6(6–10)
			36–60	Loamy fine sand and medium sand.	SM or SP-SM	A-2-4
Waukegan: 350A, 350B, 350C	>10	>5	0–8	Silt loam	ML or CL	A-4(4–8)
			8–27	Light and medium silty clay loam.	CL	A-7-6(10–12)
			27–36	Loam and sandy loam	CL or SC	A-4 (1–5) or A-6 (4–8)
			36–60	Loamy sand	SM or SP-SM	A-2-4 or A-1-b
Whalan: 207C2	2–3½	>5	0–9	Loam	ML or CL	A-4 (4–8)
			9–20	Heavy and light clay loam.	CL	A-6 (6–10)
			20–31	Clay loam	CL or CH	A-6 (8–12) or A-7-6 (12–18)
			31	Limestone.		
Whittier: 352A, 352B, 352C2	>10	>5	0–11	Silt loam	ML or CL	A-4 (6–8)
			11–32	Light and medium silty clay loam.	CL	A-7-6 (10–12)
			32–37	Heavy loam	CL	A-6 (6–10)
			37–60	Loamy fine sand and fine sand.	SM or SP-SM	A-2-4 or A-3

[1] The pH values are for measurements made in water.

[2] Perched water table at a depth of 1½ to 2 feet during extended wet periods.

[3] Bedrock at a depth of approximately 2 to 3½ feet.

[4] Perched water table at a depth of 3 to 3½ feet for short periods during extended wet periods.

significant to engineering—Continued

Percentage passing sieve—			Permeability	Available water capacity	Reaction [1]	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
			In./hr.	*In./in. of soil*	*pH*	
100	100	95–100	0. 63–2. 00	0. 18–0. 23	5. 6–6. 5	Low.
100	100	95–100	0. 06–0. 20	0. 15–0. 18	5. 6–6. 5	High.
100	100	95–100	0. 63–2. 00	0. 18–0. 23	5. 6–6. 5	Low.
100	100	95–100	0. 06–0. 20	0. 15–0. 18	5. 1–6. 0	High.
100	100	95–100	0. 63–2. 00	0. 18–0. 23	6. 1–6. 5	Moderate.
100	95–100	5–20	6. 30–20. 0+	0. 02–0. 06	6. 6–7. 3	Very low.
100	100	55–75	0. 63–2. 00	0. 15–0. 19	5. 6–6. 0	Moderate.
100	100	35–60	2. 00–6. 30	0. 10–0. 14	5. 1–5. 5	Low or moderate.
100	100	5–30	6. 30–20. 0+	0. 02–0. 08	5. 1–5. 5	Very low.
100	100	95–100	0. 63–2. 00	0. 19–0. 22	6. 6–7. 3	Moderate.
100	100	95–100	0. 63–2. 00	0. 18–0. 20	5. 1–6. 5	Moderate to high.
95–100	80–90	40–65	0. 20–0. 63	0. 14–0. 18	5. 1–7. 8	Moderate.
100	95–100	65–80	0. 63–2. 00	0. 15–0. 20	6. 1–6. 5	Moderate.
95–100	95–100	45–75	0. 63–2. 00			
85–90	70–85	3–15	6. 30–20. 0	0. 02–0. 06	6. 1–7. 3	Very low.
100	95–100	65–80	0. 63–2. 00	0. 15–0. 20	6. 1–7. 3	Moderate.
95–100	95–100	55–75	0. 63–2. 00	0. 14–0. 18	5. 6–6. 5	Moderate.
100	90–100	10–20	6. 30–20. 0	0. 02–0. 06	5. 6–6. 5	Very low.
100	100	95–100	0. 63–2. 00	0. 19–0. 20	6. 1–7. 3	Moderate.
100	100	95–100	0. 20–0. 63	0. 19–0. 21	5. 1–6. 5	Moderate.
100	90–100	30–75	0. 63–6. 30	0. 10–0. 18	5. 1–5. 5	Moderate.
100	90–100	5–20	6. 30–20. 0	0. 04–0. 06	5. 6–6. 0	Very low.
100	95–100	55–75	0. 63–2. 00	0. 14–0. 18	5. 1–6. 0	Moderate.
95–100	90–95	60–70	0. 63–2. 00	0. 14–0. 18	4. 5–5. 5	Moderate.
95–100	90–95	60–70	0. 20–0. 63	0. 16–0. 18	6. 1–6. 5	High.
100	100	95–100	0. 63–2. 00	0. 18–0. 23	6. 6–7. 3	Moderate.
100	100	95–100	0. 63–2. 00	0. 19–0. 21	5. 6–6. 5	Moderate to high.
100	90–100	55–70	0. 63–2. 00	0. 14–0. 18	5. 6–6. 0	Moderate.
100	100	5–20	0. 63–20. 0+	0. 04–0. 06	5. 1–6. 0	Very low.

[5] Bedrock at a depth of approximately 2½ to 3½ feet.

[6] Perched water table at a depth of 1 to 2 feet during extended wet periods.

[7] Water table generally at a depth of more than 5 feet; perched water table may be at a depth of 2 to 3 feet during extended wet periods.

TABLE 5.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in for referring to other series that

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Aredale: 426A, 426B, 426C.	Good in upper 1 to 2 feet; fair below depth of 4 feet.	Not suitable: thin, discontinuous, sandy layer.	Not suitable	Fair to good: fair to good compaction, bearing capacity, and shear strength; moderate shrink-swell potential.	High organic-matter content in surface layer; seepage may occur in some cuts; high susceptibility to frost action where pockets of water-bearing sand occur.	Fair to good bearing capacity; low compressibility in substratum; uneven consolidation; moderate shrink-swell potential.
Atterberry: 291A, 291B	Fair: only thin layer with moderate amounts of organic matter.	Not suitable	Not suitable	Poor: fair bearing capacity and shear strength; moderate to high shrink-swell potential; difficult to compact to high density.	Nearly level topography; seasonal high water table; low borrow potential.	Moderate to high compressibility; uniform consolidation; fair bearing capacity.
T291A	Fair: only thin layer with moderate amounts of organic matter.	Not suitable to a depth of 48 inches; fair below depth of 48 inches.	Not suitable	Poor: fair bearing capacity and shear strength; moderate to high shrink-swell potential; difficult to compact to high density.	Nearly level topography; seasonal high water table; low borrow potential; water-bearing sand occurs in places below depth of 48 inches.	Moderate to high compressibility; uniform consolidation; fair bearing capacity.
351A	Fair: thin layer of organic matter.	Fair below depth of 42 inches; fine and coarse sand with some gravel.	Poor: small amount of gravel at depth of 42 inches; contains too many fines in places.	Fair to poor to depth of 42 inches: fair to poor bearing capacity; moderate to high shrink-swell potential; good below depth of 42 inches.	Seasonal high water table; low borrow potential; low bearing capacity to depth of 42 inches, good below depth of 42 inches.	Moderate to high compressibility; uniform consolidation; poor bearing capacity and shear strength; good bearing capacity and shear strength below depth of 42 inches.
Bassett: 171B, 171C, 171C2, 171D2, 171E2, 171F2.	Fair in upper 12 to 18 inches; low in organic-matter content; poor below depth of 24 inches; clayey; low fertility.	Not suitable	Not suitable	Good below depth of 18 to 24 inches: low compressibility; easily compacted to high density.	Generally rolling topography; fair to good bearing capacity; seepage in some cuts; perched water table in wet seasons.	Good bearing capacity below depth of 24 inches; low compressibility; possible uneven consolidation.

interpretations of soils

such mapping units may have different properties and limitations and for this reason it is necessary to follow carefully the instructions appear in the first column of this table]

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Moderate permeability; sand lenses common; reservoir bottom should be scarified and compacted.	Adequate strength and stability; fair to good compaction; low permeability when compacted.	Not needed	Sand strata below depth of 3 feet in places.	Features favorable.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent.	Moderate where slopes are less than 9 percent; sand strata and pockets; moderate permeability.
Suitable sites unlikely; moderate to moderately slow permeability; may need to be scarified and compacted to prevent seepage.	Fair stability; medium compressibility; fair compaction at optimum moisture content; moderate to high shrink-swell potential.	Seasonal high water table; moderate permeability; tile functions satisfactorily where needed.	Features favorable.	Features favorable.	Moderate: percolation rate restricted by a seasonal high water table.	Moderate: moderate permeability.
Suitable sites unlikely; rapid permeability and coarse-textured material below depth of 48 inches.	Fair stability; medium compressibility; fair compaction at optimum moisture content; moderate to high shrink-swell potential.	Seasonal high water table; moderate permeability; tile functions satisfactorily where needed.	Features favorable.	Features favorable.	Moderate: percolation rate restricted by a seasonal high water table; coarse-textured material below depth of 48 inches.	Moderate: moderate permeability; coarse-textured material below depth of 48 inches too porous to hold water.
Suitable sites generally unlikely; rapid permeability below depth of about 42 inches; substratum too porous to hold water.	Fair stability, medium compressibility, and fair compaction to depth of 42 inches; poor to good stability, fair compaction, and slight compressibility below depth of 42 inches.	Seasonal high water table; tile functions well where needed.	Features favorable.	Features favorable.	Moderate: seasonal high water table; poor filtering material at depth of 42 inches.	Severe: subsoil semipervious if compacted; substratum too porous to hold water.
Slow permeability when compacted; occasional pockets and strata of sand; may need to be compacted.	Good stability; easily compacted to low permeability; adequate strength and stability; low compressibility; large boulders in places.	Generally not needed; seepage may occur in places.	Subsoil low in fertility; stone line at depth of 18 to 24 inches; cuts should be held to a minimum; tile drainage needed where wet spots may develop.	Seasonally wet and seepy; to establish vegetation, tile needed on side of waterways to control seepage.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; restricted percolation rates; moderately slow permeability.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; sand pockets in places; moderately slow permeability.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Bertram: 809B, 809C	Fair: limestone at depth of 20 to 40 inches.	Fair: poorly graded sand; limestone at depth of 20 to 40 inches.	Not suitable: bedrock generally suitable for crushing.	Good: good bearing capacity and shear strength; bedrock excellent if crushed.	Hard fractured limestone at depth of 20 to 40 inches; rolling topography; borrow potential low because of rock.	Limestone at depth of 20 to 40 inches.
Bertrand: 793A, 793B	Fair to good: only thin layer of organic matter.	Not suitable: thin discontinuous sand strata below a depth of 3 to 4 feet.	Not suitable	Fair to poor: fair to poor bearing capacity; unstable if wet; difficult to compact to high density; narrow range of optimum moisture content for compaction.	Fair borrow potential; high volume change on compaction; fair to poor bearing capacity.	Medium to high compressibility; fair to poor bearing capacity saturation may cause soil to lose cohesion and settle; subject to liquefaction.
Burkhardt: 285C, 285D2.	Fair to depth of 1 foot; very poor below.	Good: well-graded sand and gravel below depth of 1 foot to 1½ feet.	Fair: well-graded sand and gravel below depth of 1 foot to 1½ feet; amount of gravel generally low.	Very good: well-graded sand and gravel; very low to negligible compressibility.	Good bearing capacity; erodible on steep slopes; good shear strength.	Good bearing capacity and shear strength; little or no volume change if wet.
*Chelsea: 63A, 63B, 63C, 63D, 63F, 293C, 293C2, 293D, 293D2, 293F, 293F2. For interpretations of the Fayette and Lamont soils in mapping units 293C, 293C2, 293D, 293D2, 293F, and 293F2, refer to the Fayette and Lamont series.	Poor: low in organic-matter content.	Good: poorly graded fine and medium sand.	Not suitable	Good: low shrink-swell potential; good workability unless fines are less than 15 percent; lacks stability under wheel loads unless damp.	Highly erodible; difficult to vegetate; loose sand may hinder hauling operations; seepage may occur in deep cuts.	Low compressibility; fair to good shear strength; low water table; rapid consolidation; may become quick and flow if below water table during excavation.
*Clyde: 84, 391B. For interpretations of Floyd and Schley soils in mapping unit 391B, see Floyd and Schley series.	Fair to good to depth of about 20 inches; high water table.	Not suitable	Not suitable	Very poor: high water table; high organic-matter content; poor bearing capacity; moderate to high shrink-swell potential.	Poorly drained; high water table; high organic-matter content; highly susceptible to frost action.	Poor bearing capacity; high water table; uneven consolidation.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Moderately rapid permeability in upper part; material too porous to hold water; thin, discontinuous clay residuum; fractured limestone at depth of 20 to 40 inches.	Pervious even when compacted; high stability; susceptibility to piping; low shrink-swell potential.	Not needed	Limestone at depth of 20 to 40 inches may hinder construction; difficult to maintain.	Highly erodible; difficult to construct and maintain; low fertility.	Moderate to severe: poor filtering material and bedrock at depth of 20 to 40 inches.	Severe: fractured bedrock at depth of 20 to 40 inches.
Sites generally unlikely; coarse strata in places below a depth of 3 to 4 feet.	Fair stability; fair compaction at optimum moisture content; medium to high compressibility; poor resistance to piping in some areas.	Not needed	Features favorable, but slopes commonly are short and irregular.	Features favorable.	Slight: moderate permeability.	Moderate where slopes are less than 9 percent; semipervious when compacted; coarse strata in places below depth of 3 to 4 feet.
Very rapid permeability; shallow over sand and gravel; too porous to hold water.	Permeable even though compacted; fair resistance to piping; negligible volume change if wet.	Not needed	Shallow over sand and gravel; highly erodible; irregular topography; difficult to maintain.	Highly erodible; difficult to vegetate.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent; very rapid permeability; severe danger of contamination.	Severe: very rapid permeability; substratum too porous to hold water.
Rapid permeability; too porous to hold water.	Highly erodible; low shrink-swell potential; poor resistance to piping; seepage rate high.	Not needed	Highly erodible; poor workability; difficult to maintain; unstable on slopes.	Highly erodible; very low available water capacity; difficult to vegetate.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; rapid permeability; severe danger of contamination.	Severe: material too porous to hold water.
Moderate permeability; occasional sand lenses require sealing; high water table; nearly level topography.	High organic-matter content in surface layer; fair stability; fair to good compaction; low permeability when compacted.	High water table; boulders may interfere with drainage; sand strata may become quick.	Nearly level to gently sloping waterways; seasonally wet and seepy.	Wet and seepy; tile needed to control seepage to establish vegetation; boulders interfere with construction in places.	Severe: high water table; subject to concentrated runoff; percolation rate restricted by a high water table.	Moderate: high organic-matter content in surface layer; receives local runoff; stratified coarse material in places.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Coggon: 302C2	Fair to depth of about 14 inches.	Not suitable	Not suitable	Good: low compressibility; fair to good bearing capacity; easily compacted to high density; moderate shrink-swell potential.	Seepage may occur in some cuts; susceptible to frost action where wet sand pockets occur.	Fair to good bearing capacity and shear strength; low compressibility; uneven consolidation.
*Colo:						
11B, 133. For interpretations of Ely soil in mapping unit 11B, see Ely series.	Fair to good: seasonal high water table; high organic-matter content.	Not suitable	Not suitable	Very poor: poor bearing capacity and shear strength; seasonal high water table; high compressibility; high organic-matter content to a depth of about 3 feet or more.	Seasonal high water table; subject to flooding; poor bearing capacity and shear strength.	Seasonal high water table; subject to flooding; high compressibility and uneven consolidation.
133+	Good	Not suitable	Not suitable	Very poor: high organic-matter content below depth of 6 to 20 inches; high shrink-swell potential; difficult to compact.	Subject to flooding; seasonal high water table; poor bearing capacity and shear strength.	High compressibility with uneven consolidation; subject to flooding; seasonal high water table.
*Dickinson:						
175A, 175B, 175C, 175D, 442C, 442D. For interpretations of Sparta and Tama soils in mapping units 442C and 442D, see Sparta and Tama series.	Good to depth of 1 foot to 1½ feet; fair to depth of 1½ to 3 feet; poor below.	Good below depth of about 3 feet: poorly graded fine and medium sand.	Fair to poor: small amount of gravel.	Good: good workability; low compressibility; good bearing capacity when confined.	Good workability except where fines are less than 15 percent; high moisture content in some deep cuts; highly erodible.	Good bearing capacity and shear strength; low compressibility and low shrink-swell potential.

interpretations of soils—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Moderately slow permeability; sand pockets in places.	Good stability; fair to good compaction; low permeability when compacted; good workability.	Generally not needed; occasional seepy spots.	Stone line at depth of about 14 to 24 inches; wet areas in places after terraces installed; cuts should be held to a minimum; low fertility in dense subsoil.	Seasonally seepy and wet; tile needed to control wetness to establish vegetation.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; restricted percolation rate; moderately slow permeability.	Moderate where slopes are 2 to 9 percent; severe where slopes are more than 9 percent; sand pockets in places; moderately slow permeability.
High organic-matter content; nearly level topography; subject to flooding.	High organic-matter content in upper 3 feet or more; difficult to compact; high shrink-swell potential.	Seasonal high water table; subject to flooding; moderately slow permeability; tile function satisfactorily where needed.	Terraces not needed; features favorable for diversions.	Seepy; tile needed to control seepage to establish vegetation.	Severe: seasonal high water table; subject to flooding; restricted percolation rate.	Severe: moderately slow permeability; seasonal high water table; subject to flooding; high organic-matter content.
Nearly level topography; moderately slow permeability if compacted; high organic-matter content below depth of 6 to 20 inches; subject to flooding.	High organic-matter content below depth of 6 to 20 inches; poor compaction when wet; high shrink-swell potential.	Seasonal high water table; moderate permeability; tile functions satisfactorily where needed.	Features favorable.	Seepy; tile needed to control seepage to establish vegetation.	Very severe: seasonal high water table; subject to flooding.	Severe: moderately slow permeability; seasonal high water table; subject to flooding; high organic-matter content below depth of 6 to 20 inches.
Substratum too porous to hold water; rapid permeability.	Pervious when compacted; low shrink-swell potential; poor resistance to piping.	Not needed	Highly erodible; difficult to maintain; cuts should be held to a minimum because of low-fertility, droughty subsoil.	Highly erodible; difficult to vegetate.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent; poor filtering material may allow effluent to travel long distances.	Severe: moderately rapid permeability; subsoil too porous to hold water.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Dickinson—Continued 409B, 409C	Good to depth of 1 foot to 1½ feet; fair to poor to depth of 1½ to 3 feet; poor below.	Fair below depth of 2 to 3 feet; unsuitable at depth of about 3 feet.	Very poor to not suitable: small amount of gravel may be above the glacial till.	Good: good workability and low compressibility in upper part; good below depth of about 3 feet, low compressibility and easily compacted to high density.	Highly erodible; high moisture content in some cuts; good bearing capacity and shear strength below depth of 3 to 3½ feet.	Good bearing capacity and shear strength; low compressibility and low shrink-swell potential.
Dinsdale: 377B, 377C, 377C2.	Good: surface layer high in organic-matter content.	Not suitable	Not suitable	Fair in upper 20 to 40 inches; good in the till; fair to good bearing capacity; good compaction and workability; low compressibility below depth of 20 to 40 inches.	Surface layer high in organic-matter content; seepage may occur in some cuts; high frost-heave potential in sand pockets.	Good bearing capacity and shear strength; low compressibility in till; subject to frost action.
Dodgeville: 204B, 204C.	Good in upper part of surface layer; bedrock at depth of 30 to 40 inches.	Not suitable	Not suitable: no gravel below depth of 30 to 40 inches; limestone suitable for crushing.	Fair to poor in upper 30 to 40 inches; surface layer high in organic-matter content; bedrock good at depth of 30 to 40 inches if crushed.	Hard level-bedded limestone at depth of 30 to 40 inches; surface layer high in organic-matter content.	Limestone bedrock at depth of 30 to 40 inches.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Upper part of subsoil is too porous to hold water and has rapid permeability; lower part of subsoil in glacial till has slow permeability when compacted.	Pervious when compacted; low shrink-swell potential, and poor resistance to piping in upper part of subsoil; easily compacted to high density and moderate volume change with moisture in lower part of subsoil and substratum.	Generally not needed; hillside seepage in some areas; tile may be beneficial in these spots.	Highly erodible; poor stability on steep slopes; difficult to maintain ridge and channel; may expose high-density subsoils, and wet spots may develop after terracing.	Highly erodible; difficult to vegetate	Slight to moderate where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent; rapid permeability; moderate danger of contamination in upper subsoil; moderately slow permeability in lower subsoil.	Severe: rapid permeability in upper part; material too porous to hold water; glacial till of substratum has moderately slow permeability.
Moderately low permeability when compacted; bottom should be scarified and compacted; sand pockets and lenses in places.	Adequate strength and stability; easily compacted below depth of 30 to 40 inches; moderate expansion potential; small volume change below depth of 20 to 40 inches.	Not needed......	Soil features favorable; slopes typically uniform but cuts should be held to a minimum to avoid exposing the underlying, low-fertility glacial till.	Seepy; tile needed to establish vegetation.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent.	Slight where slopes are less than 2 percent; moderate where slopes are 2 to 9 percent; severe where slopes are more than 9 percent; moderately slow permeability in lower part.
Fractured limestone at depth of 30 to 40 inches; excessive seepage; clayey residuum thin and discontinuous.	Limited material available; difficult to compact to high density.	Not needed......	Soil material above bedrock favorable but limestone bedrock at depth of 30 to 40 inches may interfere with construction.	Bedrock at depth of 30 to 40 inches may interfere with construction.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; bedrock at depth of 30 to 40 inches; effluent may contaminate ground water.	Severe on all slopes; fractured bedrock at depth of 30 to 40 inches.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Donnan: 772	Poor: thin layer of organic matter; seasonally wet.	Not suitable	Not suitable	Fair to poor in upper 20 to 40 inches; narrow range of moisture for satisfactory compaction; very poor below depth of 20 to 40 inches; high shrink-swell potential.	Seasonal high water table; high susceptibility to frost heave; size of area generally small.	Seasonal high water table; high shrink-swell potential; high compressibility.
782B, 782C2	Fair to depth of 24 inches; very poor below.	Not suitable	Not suitable	Fair in upper 20 to 40 inches; fair bearing capacity; very poor below depth of about 24 inches; poor workability when wet; high shrink-swell potential.	Seasonal perched water table; high susceptibility to frost heave; surface layer moderately high in organic-matter content.	Substratum subject to high volume change if initially dry; uneven consolidation; fair bearing capacity and shear strength; high compressibility.
Downs: 162B, 162C, 162C2, 162D, 162D2.	Good to depth of 12 inches; fair below.	Not suitable	Not suitable: no gravel.	Fair: high shrink-swell potential; difficult to compact to high density; very narrow range of moisture for satisfactory compaction.	Rolling topography; high moisture may be encountered in deep cuts; easy to vegetate; fair bearing capacity and shear strength.	Medium to high compressibility; uniform consolidation; fair bearing capacity and shear strength.
Ely: 428B	Good to depth of about 24 inches: high in organic-matter content.	Not suitable	Not suitable	Poor: moderate to high shrink-swell potential; difficult to compact; surface layer high in organic-matter content; poor bearing capacity.	High organic-matter content; seasonal high water table; subject to local overflow for short durations.	Poor bearing capacity; moderate to high compressibility; subject to local overflow for short durations.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Low relief; suitable sites unlikely; very slow permeability.	Poor workability; impervious when compacted; high shrink-swell potential.	Seasonal high water table; very slow permeability; tile may not work in all areas.	Not needed because of topography.	Generally not needed; level topography.	Severe: seasonal high water table; impervious subsoil.	Slight where slopes are less than 2 percent; substratum has very slow permeability when compacted.
Low relief; very slow permeability; reservoir area not always uniform and may contain sand pockets; areas typically small.	Fair stability; poor workability; impervious when compacted; high shrink-swell potential.	Perched water table in wet periods; very slow permeability.	Seasonally wet and seepy; slopes short and irregular; cuts should be held to a minimum because of low fertility; very slow permeability below depth of 30 to 40 inches.	Seepy and wet; tile needed to establish vegetation.	Severe: very slow permeability below depth of 20 to 40 inches; seasonal perched high water table.	Slight where slopes are 2 to 5 percent; moderate where slopes are 5 to 9 percent; very slowly permeable material below a depth of about 24 inches.
Reservoir bottom should be scarified and compacted; some seepage can be expected; moderate permeability; uniform material.	Fair stability; medium to high compressibility; susceptible to piping.	Not needed.	Features generally favorable.	Features generally favorable; tile helps prevent seepage to establish vegetation.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent; satisfactory percolation rate.	Moderate where slopes are 2 to 9 percent; severe where slopes are more than 9 percent; moderately slow permeability.
Moderately slow permeability; difficult to compact; coarse-textured layer may be encountered below depth of 48 inches.	Fair stability; moderate to high shrink-swell potential; high in organic-matter content.	Seasonally wet due to seepage; use interceptor tile.	Soil features favorable; diversions will help protect from overflow or runoff from higher land.	Soil features favorable; tile needed to prevent seepage to establish vegetation.	Moderate to severe: seasonal high water table; somewhat poorly drained; subject to short duration runoff from higher land.	Moderate to severe: subject to short duration runoff from higher land; surface layer high in organic-matter content.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Fayette: 163B, 163C, 163C2, 163D, 163D2, 163D3, 163E, 163E2, 163E3, 163F, 163F2.	Fair to depth of about 6 to 12 inches; poor below; low in organic-matter content.	Not suitable.	Not suitable.	Fair to poor: fair bearing capacity when wet; difficult to compact to high density; very narrow range of moisture for satisfactory compaction.	Rolling topography; easy to vegetate; high moisture may be encountered in deep cuts; fair shear strength; highly erodible.	Medium to high compressibility; uniform consolidation; fair bearing capacity and shear strength; highly erodible.
T163B	Fair to depth of about 6 to 12 inches; poor below; low in organic-matter content.	Fair to poor: poorly graded sand below depth of 48 inches in some areas.	Not suitable.	Fair: good below depth of 48 inches if sand is encountered; fair bearing capacity above depth of 48 inches; low density material in upper horizon.	Low borrow potential in uppermost 48 inches; fair bearing capacity; easy to vegetate except where coarse strata occur.	Fair bearing capacity and shear strength; medium to high compressibility to depth of 48 inches; low below; uniform consolidation.
Flagler: 284A, 284B, 284C, 284C2.	Fair to good to depth of about 12 to 18 inches.	Good: generally well-graded gravelly sand below depth of 24 to 36 inches.	Fair to good: some sites may contain pockets and thin lenses of well-graded gravel; may contain too much sand for commercial use.	Good to excellent: good bearing capacity; very low shrink-swell potential; stable when damp.	Typically low relief; very stable; slope protection required; difficult to vegetate cuts.	Very low compressibility; good bearing capacity and shear strength; very low shrink-swell potential.
Floyd: 198B	Good to depth of 18 to 24 inches; fair below; seasonally wet.	Not suitable; sand strata thin and discontinuous.	Not suitable.	Poor in upper part; high in organic-matter content; difficult to compact to high density. Fair suitability in lower strata: high density material; good compaction and workability.	Low relief; high in organic-matter content; seasonal high water table; high susceptibility to frost heave; fair bearing capacity and shear strength in lower part.	Fair bearing capacity below depth of 24 to 36 inches; seasonal high water table; uneven consolidation; subject to frost heave.
Franklin: 761A, 761B.	Fair: thin layer of organic matter.	Not suitable.	Not suitable.	Fair in upper 20 to 40 inches: narrow range of optimum moisture for satisfactory compaction. Good below: high density material; good workability and compaction.	Seasonal high water table; low relief; high susceptibility to frost heave.	Seasonal high water table; subject to frost heave; moderate to high shrink-swell potential; fair bearing capacity in upper 20 to 40 inches, good below.

interpretations of soils—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways		Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments						
Moderate permeability; uniform material; reservoir bottom should be scarified and compacted; subject to seepage.	Fair stability; high compressibility; fair compaction at or near optimum moisture; moderate to high shrink-swell potential.	Not needed	Features generally favorable.	Seepy in some areas; tile needed to establish vegetation.		Slight where slopes are 2 to 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent.	Moderate where slopes are 2 to 9 percent; severe where slopes are more than 9 percent; moderate permeability.
Moderate permeability above depth of 48 inches; coarse strata below depth of 48 inches in some areas; reservoir bottom should be scarified and compacted.	Fair stability; high consolidation; fair compaction at or near optimum moisture; poor resistance to piping.	Not needed	Features generally favorable.	Features generally favorable.		Slight: moderate permeability; some danger of contaminating ground water where sand is at depth of about 48 inches.	Moderate to severe: moderate permeability; sandy strata may be encountered at depth of about 48 inches.
Substratum too porous to hold water; very rapid permeability below depth of about 24 inches.	Semipervious when compacted; good workability; subject to piping; very low shrink-swell potential.	Not needed	Sandy subsoil is gravelly below depth of 24 inches; very low fertility; difficult to vegetate; cuts should be minimal.	Highly erodible; difficult to vegetate.		Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent; very rapid permeability below depth of about 24 inches; severe danger of contamination.	Severe on all slopes: material too porous to hold water; very rapid permeability below depth of about 24 inches.
Material not uniform; reservoir area should be scarified and compacted; sand pockets and strata are common.	Fair stability in in substratum; low permeability when compacted in substratum; poor resistance to piping in some areas; high in organic-matter content.	Seasonal high water table; moderate permeability.	Features generally favorable.	Seasonally wet and seepy; to establish vegetation, tile needed on sides of waterway to control seepage.		Severe: seasonal high water table; satisfactory percolation rates.	Moderate: high organic-matter content; stratified with sand in upper 24 to 48 inches.
Nearly level topography; suitable sites unlikely; moderately slow permeability in lower part.	Good stability; low permeability when compacted; moderate to high shrink-swell potential.	Seasonal high water table; moderate permeability in upper part; moderately slow permeability in lower part; tile not needed in some areas.	Generally not needed due to topography; soil features generally favorable.	Generally not needed due to topography; tile needed to establish vegetation.		Moderate to severe: seasonal high water table.	Slight: occasional sand strata; slow permeability in substratum when compacted.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Garwin: 118	Fair: moderately fine-textured material; high in organic-matter content.	Not suitable	Not suitable	Poor: highly elastic; moderate to high shrink-swell potential; poor bearing capacity; difficult to compact to high density; high in organic-matter content.	Seasonal high water table; high in organic-matter content; low borrow potential; level topography.	Poor bearing capacity; saturation may cause high compressibility; uniform consolidation.
Hayfield: 725	Good in upper 12 inches; fair to depth of 24 inches; very poor below.	Good below depth of 24 to 36 inches: well-graded fine to coarse sand or well-graded sand and gravel.	Fair below depth of 24 inches: well-graded fine to coarse sand; may contain too many fines.	Fair in upper 24 inches; good below depth of 24 inches; very low compressibility; good workability; seasonal high water table at depth of 24 to 36 inches.	Seasonal high water table; nearly level topography; fair bearing capacity and shear strength to depth of about 24 inches, good bearing capacity and good to excellent shear strength below.	Seasonal high water table; medium to high compressibility to a depth of 24 inches; good bearing capacity and low compressibility below depth of 24 inches; susceptibility to frost heave; fair bearing capacity in subsoil; good bearing capacity in substratum.
726	Good in upper 12 inches; fair to depth of 12 to 36 inches; very poor below.	Good below depth of 36 inches: well-graded fine to coarse sand and well-graded sand and gravel.	Fair below depth of 36 inches: well-graded fine and coarse sand; may contain too many fines.	Fair in upper part: moderate shrink-swell potential. Good below depth of 30 to 36 inches: good stability when confined; seasonal high water table at depth of 24 to 36 inches.	Seasonal high water table; fair bearing strength at depth of 24 to 36 inches; good bearing capacity and good to excellent shear strength below depth of 36 inches.	Low to medium compressibility; seasonal high water table; good bearing capacity below depth of 36 inches but may become quick and flow if excavated when wet.
Judson: 8B	Very good to depth of 24 inches: high in organic-matter content.	Not suitable	Not suitable	Poor: high in organic-matter content in upper 24 to 36 inches; poor bearing capacity; difficult to compact to high density.	Subject to local runoff; may have seepy areas in some places; high in organic-matter content.	High compressibility; fair bearing capacity and shear strength; subject to local runoff from higher elevations.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Nearly level topography; suitable sites unlikely; reservoir bottom should be compacted; uniform material.	Poor stability at high moisture; moderate to high shrink-swell potential; high compressibility.	Seasonal high water table; tile functions satisfactorily.	Not needed due to topography.	Soil features favorable where needed; to establish vegetation, tile needed to control seepage.	Severe to very severe: seasonal high water table; poorly drained.	Moderate: surface layer high in organic-matter content; moderately slow permeability in substratum.
Nearly level topography; suitable sites unlikely; substratum too porous to hold water; fluctuating water table.	Adequate shear strength and stability; moderate organic-matter content in upper part; poor resistance to piping; very low shrink-swell potential.	Seasonal high water table; tile placement difficult in some areas due to water-bearing sands.	Not needed due to topography.	Features generally favorable.	Moderate: seasonal high water table; poor filtering material below depth of 24 inches; moderate danger of contamination of ground water; subject to occasional overflow.	Severe: substratum too coarse to hold water; surface layer high in organic-matter content; seasonal high water table; subject to occasional overflow.
Nearly level topography; substratum too porous to hold water; fluctuating water table; suitable sites unlikely.	Fair stability to a depth of about 36 inches; fair to good compaction; moderate to low shrink-swell potential; poor resistance to piping.	Seasonal high water table; will benefit from tile drainage; tile placement is difficult in many areas due to water-bearing sand.	Not needed due to topography.	Features generally favorable.	Moderate: seasonal high water table; moderate danger of contamination of ground water; somewhat poorly drained; subject to overflow in places.	Severe: seasonal high water table at depth of 24 to 36 inches; substratum too porous to hold water; subject to overflow in some places.
Moderate permeability; high in organic-matter content; reservoir bottom should be scarified and compacted; some seepage can be expected.	Fair stability; high compressibility; moderate shrink-swell potential; difficult to compact except at optimum moisture.	Soil features favorable; most areas do not need tile; use interceptor tile in seepy areas.	Soil features favorable.	Soil features favorable; tile helps to control seepage to establish vegetation.	Slight: receives runoff and deposition from higher adjacent areas; moderate permeability.	Moderate: subject to short duration runoff from higher ground; high organic-matter content.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Kennebec: 212	Good: thick surface layer high in organic-matter content.	Not suitable: no sand or sand layer is thin and discontinuous.	Not suitable	Very poor: high in organic-matter content in upper 24 to 36 inches; poor bearing capacity; high compressibility.	Subject to overflow; high in organic-matter content in upper 24 to 36 inches; poor bearing capacity.	Poor bearing capacity; fair shear strength; subject to overflow; water table occasionally above depth of 48 inches.
Kenyon: 83B, 83C, 83C2, 83D2.	Good in upper 12 inches; fair to depth of 24 inches; poor below.	Not suitable	Not suitable	Good below depth of 24 inches: good bearing capacity; easily compacted to high density; moderate shrink-swell potential.	Surface layer high in organic-matter content; high susceptibility to frost heave; may have seepy areas in some cuts; good bearing capacity.	Good bearing capacity and shear strength; low compressibility; may have uneven consolidation.
*Klinger: 184A, 381B. For interpretations of Maxfield soil in mapping unit 381B, see Maxfield series.	Good: thick surface layer; high in organic-matter content.	Not suitable	Not suitable	Poor in upper 20 to 40 inches: moderate to high shrink-swell potential; fair bearing capacity; good suitability in substratum; good workability; easily compacted to high density; low compressibility.	Nearly level topography; seasonal high water table; surface layer high in organic-matter content; good bearing capacity and shear strength below depth of 24 to 36 inches.	Seasonal high water table; moderate compressibility; fair bearing capacity and shear strength; good below depth of 24 to 36 inches.
Lamont: 110B, 110C	Fair in upper 30 inches; poor below.	Good: poorly graded fine and medium sand.	Poor: no gravel in most areas; stream benches may contain small amounts.	Good: low shrink-swell potential; good workability and compaction except where fines are less than 15 percent; good bearing capacity and shear strength.	High moisture in some cuts; good borrow potential; highly erodible when exposed on embankments; loose sand may hinder hauling operations; good bearing capacity and shear strength.	Good bearing capacity and shear strength; low compressibility; rapid consolidation.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Moderate permeability; subject to overflow; fluctuating water table.	High in organic-matter content to depth of 24 to 36 inches; fair stability and compaction below surface layer.	Seasonal high water table; may need overflow protection; tile not needed in most areas.	Not needed due to topography.	Generally not needed; soil features favorable.	Severe: subject to overflow; high water table occasionally above depth of 48 inches.	Severe: subject to overflow; fluctuating water table.
Difficult to find suitable sites; reservoir bottom should be scarified and compacted; sand pockets occur in some areas; moderately slow permeability.	Fair to good stability; surface layer high in organic-matter content; moderate shrink-swell potential.	Moderately slow permeability; some hillside seeps; tile generally not needed.	Cuts should be held to a minimum, generally less than 24 inches; wet spots may develop and benefit from tile drainage; prominent stone line at depth of 24 inches in some places; subsoil compacts easily; low fertility.	Soil features generally favorable; tile helps to control seepage.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; restricted percolation rate.	Moderate where slopes are 2 to 9 percent: surface layer high in organic-matter content; occasional sand pockets; moderately slow permeability.
Nearly level topography; suitable sites unlikely; reservoir bottom should be compacted to prevent seepage; few sand strata below depth of 24 to 36 inches.	Fair stability to depth of 20 to 40 inches, good below; substratum has low permeability when compacted; high in organic-matter content.	Seasonal high water table; tile functions well; not all areas need tile.	Generally not needed due to topography; soil features favorable.	Soil features favorable; to establish vegetation, tile needed on side of waterways to prevent seepage.	Moderate: seasonal high water table.	Moderate: surface layer high in organic-matter content; few sand strata; low permeability in substratum when compacted.
Material too porous to hold water; rapid permeability in substratum.	Fair stability; pervious when compacted; poor resistance to piping; low shrink-swell potential.	Not needed.	Loose, sandy substratum may hinder construction; difficult to maintain ridge and channel; highly erodible.	Highly erodible; difficult to vegetate.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; severe where slopes are more than 9 percent; severe danger of contamination.	Severe on all slopes: material too porous to hold water.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Lawler: 225	Good to depth of 12 to 18 inches.	Good below depth of 24 inches: well-graded fine to coarse sand and some gravel.	Fair below depth of 24 inches: well-graded coarse sand and some gravel; may contain too many fines.	Fair to poor in subsoil: low density; moderate shrink-swell potential; low stability at optimum moisture; good suitability and low compressibility in substratum.	Nearly level topography; seasonal high water table; surface layer high in organic-matter content; good bearing capacity and shear strength at depth of 24 inches.	Subject to occasional overflow; medium to high compressibility in upper part, low in substratum; seasonal high water table; high susceptibility to frost heave; good bearing capacity below depth of 24 inches.
226	Good to depth of 12 to 18 inches.	Good below depth of 36 inches: well-graded fine and coarse sand and some gravel.	Fair below depth of 36 inches: well-graded coarse sand and some gravel; may contain too many fines.	Poor in upper 36 inches: high organic-matter content. Good below depth of 36 inches.	Seasonal high water table; surface layer high in organic-matter content; good bearing capacity and shear strength below depth of 36 inches.	Seasonal high water table; low compressibility below depth of 36 inches and good shear strength but may become quick and flow if saturated during excavation.
Lawson: 484	Very good: high organic-matter content.	Fair to poor below depth of 48 to 60 inches.	Poor: low amount of gravel below depth of 60 inches.	Poor: poor bearing capacity; poor stability at optimum moisture; difficult to compact to high density; narrow range of moisture content for satisfactory compaction.	Subject to flooding; seasonal high water table; surface layer high in organic-matter content; poor bearing capacity.	Moderate to high compressibility; subject to overflow; poor bearing capacity and shear strength.
Loamy alluvial land: 315.	Good to fair: variable in places.	Fair to poor: poorly graded sands; variable.	Fair to poor: gravel bars adjacent to streams in some places.	Good to poor: onsite investigation required.	Subject to flooding; high water table in places; surface layer high in organic-matter content in many areas; soil material variable.	Soil materials variable; high water table in many areas; subject to flooding.
Loamy terrace escarpments: 154F. Properties too variable to estimate.						
Marsh: 354. Properties too variable to estimate.						

interpretations of soils—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways		Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments						
Nearly level topography; suitable sites unlikely; fluctuating water table; substratum too porous to hold water.	Fair shear strength and stability; surface layer high in organic-matter content; poor resistance to piping.	Seasonal high water table; will benefit from tile; tile placement difficult in many places due to water-bearing sand.	Nearly level topography; terraces not needed.	Generally not needed.		Moderate: seasonal high water table; severe danger of contamination of streams and ground water; subject to overflow in some areas.	Severe: substratum too porous to hold water; severe danger of contamination of streams and ground water; surface layer high in organic-matter content.
Nearly level topography; suitable sites unlikely; fluctuating water table; substratum too porous to hold water.	Fair stability above depth of 36 inches, high stability below; poor resistance to piping.	Seasonal high water table; will benefit from tile; tile placement difficult in many places due to water-bearing sand.	Generally not needed; level topography; soil features favorable.	Generally not needed.		Moderate: seasonal high water table; severe danger of contamination of streams and ground water; subject to overflow in some areas.	Severe: substratum too porous to hold water; severe danger of contamination of streams and ground water; somewhat poorly drained; surface layer high in content of organic matter; some areas subject to overflow.
Nearly level bottom lands; suitable sites unlikely; sand strata may be encountered below depth of 48 inches; fluctuating water table; subject to overflow.	Fair stability; difficult to compact to high density; high organic-matter content; subject to piping.	Seasonal high water table; subject to overflow.	Soil features favorable.	Generally not needed due to topography; soil features favorable.		Moderate to very severe: seasonal high water table; subject to overflow.	Severe: subject to overflow; fluctuating water table.
Suitable sites unlikely; nearly level bottom land; subject to flooding; material too porous to hold water in many places.	Soil materials variable; surface layer generally high in organic-matter content; medium to high shrink-swell potential.	Soil material variable; subject to flooding; high water table in places; difficult to find adequate tile outlets.	Terraces not needed due to topography; soil material variable.	Generally not needed; nearly level bottom lands.		Very severe: subject to flooding; seasonal high water table.	Very severe: subject to flooding; seasonal high water table; soil material variable.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Marshan: 151	Good in upper 12 to 18 inches; poor below depth of about 24 inches.	Good below depth of 24 inches: well-graded fine and coarse sand and some gravel.	Fair below depth of 24 inches: small amounts of gravel; may contain too many fines.	Very poor in upper 24 inches: surface layer high in organic-matter content. Good below depth of 24 inches: good bearing capacity; very low shrink-swell potential.	Seasonal high water table; surface layer high in organic-matter content; susceptibility to frost heave.	Seasonal high water table; subject to occasional overflow; good bearing capacity and shear strength below depth of about 24 inches.
152	Good in upper 12 to 18 inches; fair to depth of 18 to 36 inches; surface layer high in organic-matter content.	Good below depth of 48 inches: well-graded fine and coarse sand and some gravel.	Fair below depth of 48 inches: small amount of gravel; may contain too many fines.	Very poor in upper 36 to 48 inches: moderate to high shrink-swell potential; poor bearing capacity. Very good in substratum: very low shrink-swell potential; high stability.	Seasonal high water table; surface layer high in organic-matter content; susceptibility to frost heave.	Seasonal high water table; may become quick during excavation below water table; subject to occasional overflow; good bearing capacity and shear strength below depth of about 36 inches.
Maxfield: 382	Fair: moderately fine-textured, thick layer high in organic-matter content.	Not suitable	Not suitable	Poor in upper 20 to 40 inches: high in organic-matter content; poor bearing capacity; difficult to compact. Good suitability below depth of 20 to 40 inches: easily compacted to high density; good workability.	Seasonal high water table; nearly level topography; high in organic-matter content; susceptible to frost heave.	Seasonal high water table; moderately slow permeability; poor bearing capacity; high shrink-swell potential.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Substratum too porous to hold water; fluctuating water table; subject to occasional overflow.	Fair stability in upper inches; sand and gravel below.	Seasonal high water table; tile placement difficult in some places due to water-bearing loose sand.	Generally not needed due to topography.	Tile needed on sides of waterways in places to control seepage and to establish vegetation.	Severe: seasonal high water table; subject to occasional overflow; moderate danger of contamination of ground water.	Severe: substratum too porous to hold water; surface layer high in organic-matter content; seasonal high water table; subject to occasional overflow; moderate danger of contamination of ground water.
Substratum too porous to hold water; fluctuating water table; subject to occasional overflow.	Moderate to high shrink-swell potential; semipervious when compacted; substratum has very low shrink-swell potential; susceptible to piping.	Seasonal high water table; tile placement difficult in some places due to water-bearing loose sand.	Generally not needed due to topography.	Tile needed on sides of waterways to control seepage and to establish vegetation.	Severe: seasonal high water table; subject to occasional overflow; moderate danger of contamination of ground water.	Severe: seasonal high water table; subject to occasional overflow; substratum too porous to hold water; moderate danger of contamination of ground water.
Nearly level topography; suitable sites unlikely; moderately slow permeability.	Fair stability; semipervious when compacted; low compressibility in substratum; high shrink-swell potential in upper part.	Seasonal high water table.	Generally not needed due to topography.	Tile needed on sides of waterways to control seepage and to establish vegetation.	Severe: seasonal high water table; moderately slow permeability.	Moderate: surface layer high in organic-matter content; seasonal high water table.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Muck:						
21	Good in upper 18 inches if mixed with mineral soil; seasonal high water table at or near surface.	Poor: variable amount of sand.	Not suitable.	Not suitable: seasonal high water table at or near surface; very high organic-matter content.	Seasonal high water table; subject to ponding of surface water; extremely poor bearing capacity and shear strength; fair bearing capacity and shear strength below depth of 18 inches; uneven consolidation.	Seasonal very high water table; subject to ponding of surface water; organic material to depth of 12 to 24 inches; variable materials below; uneven consolidation.
221	Good to depth of 36 inches if mixed with mineral soil; seasonal high water table at or near surface.	Poor: variable amount of sand.	Not suitable.	Not suitable: organic material to depth of 36 inches; seasonal high water table at or near surface.	High in content of organic material to depth of 36 inches; seasonal high water table at or near surface; very poor bearing capacity; uneven consolidation; high compressibility.	Seasonal very high water table; subject to ponding of surface water; organic material to depth of 36 inches.
Muscatine:						
119A	Good: thick surface layer high in organic-matter content.	Not suitable.	Not suitable.	Poor: fair bearing capacity; poor shear strength; moderate to high shrink-swell potential; high organic-matter content.	Seasonal high water table; surface layer high in organic-matter content.	Moderate to high compressibility; uniform consolidation; fair bearing capacity.
T119A	Good: thick surface layer high in organic-matter content.	Fair below depth of 48 inches.	Poor: small amount in some areas below depth of 48 inches.	Poor: fair bearing capacity; poor shear strength; moderate to high shrink-swell potential; high organic-matter content.	Seasonal high water table; surface layer high in organic-matter content; water-bearing sand in places at depths below 48 inches.	Moderate to high compressibility, uniform consolidation, and fair bearing capacity to depth of 48 inches; below depth of 48 inches sandy strata have good bearing capacity and low compressibility.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Suitable sites unlikely; surface very high in organic-matter content; variable materials below organic layers; some sandy lenses and pockets in places.	Poor stability; very high organic-matter content; poor compaction characteristics.	Very high water table; water-bearing sand hinders installation in some areas.	Not needed due to topography.	Not needed due to topography.	Very severe: high water table; subject to ponding.	Very severe: high water table; organic materials in upper strata.
Suitable sites unlikely; organic material to depth of 36 inches; variable materials below.	Organic material to depth of 36 inches; poor stability; poor compaction characteristics; high compressibility.	Seasonal very high water table; organic material to depth of 36 inches; tile alinement difficult to maintain.	Not needed due to topography.	Not needed due to topography.	Very severe: seasonal high water table; subject to ponding.	Very severe: seasonal high water table; organic materials to depth of more than 36 inches.
Nearly level topography; suitable sites unlikely; reservoir may need to be compacted to prevent seepage.	Fair stability; fair compaction at optimum moisture; moderate to high organic-matter content.	Seasonal high water table; tile not needed in some areas.	Generally not needed due to topography; soil features favorable.	Seasonal seepage and wet; tile needed in places to establish vegetation.	Moderate: seasonal high water table.	Moderate: moderate permeability; surface layer high in organic-matter content.
Nearly level topography; suitable sites unlikely; coarse-textured material below depth of 48 inches.	Fair stability; fair compaction at optimum moisture; moderate to high shrink-swell potential; high organic-matter content.	Seasonal high water table; tile not needed in some areas.	Soil features favorable.	Seasonal seepage and wet; tile needed in places to establish vegetation.	Moderate: seasonal high water table; coarse-textured material below depth of 48 inches or more.	Moderate: moderate permeability; surface layer high in organic-matter content; seasonal high water table; coarse-textured material below depth of 48 inches or more.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Nevin: 88	Good: thick surface layer high in organic-matter content.	Not suitable	Not suitable	Very poor: poor bearing capacity and shear strength; moderate to high shrink-swell potential; difficult to compact properly.	Nearly level topography; high in organic-matter content; seasonal high water table.	Moderate to high compressibility; poor bearing capacity; subject to occasional overflow; seasonal high water table.
Nodaway: 220A, 220B.	Good: medium organic-matter content; subject to flooding.	Not suitable	Not suitable	Very poor: poor bearing capacity; moderate shrink-swell potential; low stability when wet; difficult to compact to high density.	Nearly level bottom lands; subject to frequent overflow; organic layer below depth of 36 inches.	High compressibility; subject to frequent overflow; poor bearing capacity.
Olin: 408B, 408C	Good in upper 12 to 18 inches; poor below.	Fair to poor: 24 to 36 inches to glacial till.	Not suitable	Good: good workability; low compressibility; easily compacted to high density.	Highly erodible in upper part; high moisture in some cuts; fair to good bearing capacity; fair shear strength below depth of 24 to 36 inches.	Good bearing capacity and shear strength; possible uneven consolidation; low compressibility.
Oran: 471A, 471B	Fair to good to depth of 18 to 24 inches; medium organic-matter content; poor below depth of 18 to 24 inches.	Not suitable	Not suitable	Fair in upper 18 to 24 inches; fair bearing capacity; good below depth of 18 to 24 inches; fair to good bearing capacity; easily compacted to high density; low compressibility.	Nearly level topography; seasonal high water table; susceptible to frost heave; fair to good bearing capacity and shear strength below depth of 18 to 24 inches.	Seasonal high water table; low compressibility; good bearing capacity and shear strength below depth of 18 to 24 inches.
Readlyn: 399A	Good in upper 12 to 18 inches; high in organic-matter content.	Not suitable	Not suitable	Good below depth of 18 to 24 inches: fair to good bearing capacity; easily compacted to high density; good workability.	Nearly level topography; seasonal high water table; surface layer high in organic-matter content.	Seasonal high water table; good bearing capacity and shear strength; low compressibility; possibility of uneven consolidation.

interpretations of soils—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways		Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments						
Nearly level topography; suitable sites unlikely; slow permeability when compacted; fluctuating water table.	Fair stability; poor compaction above optimum moisture; moderate to high shrink-swell potential; high compressibility.	Seasonal high water table; tile not needed in some areas.	Terraces not needed due to topography; soil features favorable for diversions.	Generally not needed; soil features favorable.		Moderate to severe: seasonal high water table; subject to occasional overflow for short periods.	Moderate: moderate to moderately slow permeability; surface layer high in organic-matter content; seasonal high water table; subject to occasional overflow for short periods.
Reservoir area needs to be compacted; some seepage can be expected; subject to frequent overflow.	Low stability at high moisture; poor compaction above optimum moisture; moderate shrink-swell potential; poor resistance to piping.	Seasonally wet because of overflow.	Terraces generally not needed; soil features favorable for diversions.	Wet and seepy in some areas; tile may be needed in areas to control seepage and to establish vegetation.		Moderate to severe: subject to frequent overflow; moderate permeability.	Severe: subject to frequent overflow; moderate permeability; difficult to compact to high density.
Moderately rapid permeability in upper 24 to 36 inches; slow permeability in glacial till when compacted.	Pervious in upper 24 to 36 inches if compacted; easily compacted to high density below depth of 24 to 36 inches; moderate shrink-swell potential.	Generally not needed; hillside seepage in some places; tile may be beneficial in these places.	Highly erodible in upper part; difficult to maintain ridge and channel in sandy material.	Highly erodible in upper part; difficult to vegetate; seepy and wet in places; tile needed to establish suitable vegetation.		Moderate where slopes are less than 9 percent: moderately rapid permeability in upper 24 to 36 inches; moderately slow permeability below.	Moderate where slopes are 2 to 9 percent: moderately rapid permeability to depth of 24 to 36 inches; moderately slow permeability below.
Nearly level topography; suitable sites unlikely; moderately slow permeability in lower part; sand lenses and pockets in places.	Semipervious to impervious when compacted; good workability; low compressibility; moderate shrink-swell potential.	Seasonal high water table; moderately slow permeability.	Terraces not needed in most places; low fertility in subsoil; wetness will increase with terrace installation; combination of terracing and tiling may be most successful.	Seepy and wet; tile needed on sides of waterways to control seepage and to establish vegetation.		Moderate to severe: seasonal high water table; moderately slow permeability in lower part.	Slight where slopes are less than 2 percent; moderate where slopes are 2 to 5 percent; few sand strata.
Nearly level topography; suitable sites unlikely; sand pockets and strata in some areas; slow permeability when compacted.	Good shear strength and stability; impervious when compacted; moderate shrink-swell potential.	Seasonal high water table; moderately slow permeability.	Not needed due to topography.	Not needed due to topography.		Moderate to severe: seasonal high water table; moderately slow permeability.	Slight where slopes are less than 2 percent: surface layer high in organic-matter content; a few sand pockets.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Richwood: 977	Good to depth of 18 to 24 inches; fair to good below.	Fair to poor below depth of 48 inches: sand strata may be thin and contain excessive fines.	Not suitable	Poor: moderate to high shrink-swell potential; fair bearing capacity; difficult to compact to high density.	Nearly level topography; surface layer high in organic-matter content; fair bearing capacity.	Fair bearing capacity; medium to high compressibility; uniform consolidation.
Rockton: 213B, 213C	Good to depth of 24 inches: limestone at depth of 30 to 36 inches.	Not suitable	Not suitable: possible source of limestone for crushing at depth of 30 to 36 inches.	Fair to good in upper 24 to 36 inches: moderate shrink-swell potential; good compaction. Limestone at depth of 30 to 36 inches good if crushed.	Surface layer high in organic-matter content; hard, level-bedded limestone at depth of 30 to 36 inches; fair to good bearing capacity and shear strength above limestone.	Bedrock at depth of 30 to 36 inches; fair to good bearing capacity; fair shear strength above limestone.
214B, 214C, 214D	Good to depth of 12 to 18 inches; limestone at depth of 24 inches.	Not suitable	Not suitable: possible source of limestone for crushing.	Fair to good in surface layer: upper limestone at depth of 24 inches; suitable if crushed.	Surface layer high in organic-matter content; fair to good bearing capacity and shear strength above limestone; limestone bedrock at depth of 24 inches.	Bedrock at depth of 24 inches.
Sattre: 778A, 778B, 778C2.	Good in upper 6 inches; fair to depth of 36 inches.	Good below depth of 36 inches: well-graded, fine to medium sand with some coarse sand and small amount of gravel.	Fair below depth of 36 inches: small amount of gravel; may contain too many fines.	Fair in upper 36 inches: fair bearing capacity. Good below depth of 36 inches: very low shrink-swell potential; good bearing capacity and shear strength.	Fair bearing capacity and shear strength in upper 36 inches; good bearing capacity and shear strength below depth of 36 inches.	Fair bearing capacity and shear strength in upper 36 inches; very low compressibility; very low shrink-swell potential below depth of 36 inches.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Nearly level topography; suitable sites unlikely; reservoir area should be scarified and compacted; subject to seepage; coarse strata below depth of 48 inches in some areas.	Fair stability; semipervious when compacted; susceptibility to piping in substratum; moderate to high shrink-swell potential.	Not needed	Terraces not needed due to topography; soil features favorable for diversions.	Generally not needed; soil features favorable.	Slight if well drained; moderate permeability; severe in places subject to overflow.	Moderate unless subject to overflow; semipervious even when compacted; difficult to compact to high density.
Fractured limestone at depth of 30 to 36 inches too porous to hold water; thin, discontinuous clayey residuum.	Good stability; limestone bedrock at depth of 30 to 36 inches; limited material available; good workability; moderate shrink-swell potential.	Not needed	Limestone below depth of 30 to 36 inches; bedrock may hinder construction; cuts should be held to a minimum.	Limestone below depth of 30 to 36 inches; may hinder construction.	Moderate to severe: bedrock at depth of 30 to 36 inches; some danger of ground water contamination.	Severe: fractured limestone below depth of 30 to 36 inches.
Shallow to bedrock, which is fractured and too porous to hold water; thin, discontinuous clayey residuum.	Shallow to bedrock; slow permeability when compacted; settling can be expected if fills of large fragments are used; limited available material.	Not needed	Limestone bedrock at depth of 24 inches may hinder construction.	Shallow to bedrock; may hinder construction.	Severe: fractured limestone bedrock at depth of 24 inches; danger of ground water contamination.	Severe: fractured limestone at depth of 24 inches.
Sandy material at depth of 36 inches has rapid permeability; substratum too porous to hold water.	Semipervious when compacted in subsoil; high stability in substratum; very low shrink-swell potential in substratum.	Not needed	Sand and gravel at depth of 36 inches; slopes generally short and irregular.	Sand and gravel at depth of 36 inches difficult to vegetate where exposed.	Slight to moderate where slopes are 0 to 5 percent; moderate where slopes are 5 to 9 percent; moderate hazard of contamination.	Severe on all slopes; substratum too porous to hold water; moderate danger of contamination.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Saude: 177A, 177B, 177C.	Good in upper 12 inches; fair to depth of 24 inches; poor below.	Good below depth of 24 inches: well-graded fine to coarse sand and some gravel.	Fair below depth of 24 inches: small amount of gravel; may contain too many fines.	Good below depth of 24 inches: low compressibility; good workability; very low shrink-swell potential.	Surface layer high in organic-matter content; fair bearing capacity and shear strength to depth of 24 inches; good bearing capacity and shear strength below depth of 24 inches.	Good bearing capacity and shear strength to depth of 24 inches; low compressibility; very low shrink-swell potential.
Schley: 407B	Good in upper 6 inches; fair to depth of 36 inches; poor below.	Not suitable; discontinuous sandy strata.	Not suitable	Fair: seasonal high water table; medium to low compressibility; variable material to depth of 36 inches; material below that depth easily compacted.	Fair to good bearing capacity; fair shear strength; seasonal high water table; high susceptibility to frost heave where pockets of water-bearing sand occur.	Seasonal high water table; fair to good bearing capacity and shear strength; possible uneven consolidation.
Seaton: 663D, 663D2, 663E, 663E2, 663F, 663F2.	Good in upper 6 to 12 inches; fair below; low organic-matter content.	Not suitable	Not suitable	Poor: fair bearing capacity; medium to high compressibility; difficult to compact to high density.	Rolling topography; high moisture in some cuts.	Medium to high compressibility; fair shear strength and bearing capacity; moderate shrink-swell potential.
Sogn: 412C, 412D, 412G.	Poor: shallow to bedrock.	Not suitable	Not suitable; possible source of limestone for crushing.	Good below depth of 12 inches; limestone bedrock; good if crushed.	Shallow to limestone bedrock.	Limestone bedrock below depth of 12 inches.
Sparta: 41A, 41B, 41C, 41D.	Poor: droughty.	Good: poorly graded fine and medium sand.	Poor: few places on stream benches have gravelly sand below depth of 40 inches.	Good: very low shrink-swell potential; good bearing capacity; good workability where fines are more than 15 percent; lacks stability under wheel loads except when damp.	Highly erodible; subject to seepage in deep cuts; difficult to vegetate; loose sand may hinder hauling operations; good borrow potential.	Low compressibility; good shear strength; rapid consolidation; very low shrink-swell potential; may liquefy during excavation if wet.

interpretations of soils—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Sand and gravel at depth of 24 inches; too porous to hold water.	Good stability; very low shrink-swell potential below depth of 24 inches; poor resistance to piping.	Not needed	Generally not needed; short slopes; coarse material.	Easy to vegetate unless cuts expose coarse material.	Slight where slopes are less than 5 percent; moderate hazard of ground water contamination.	Severe: substratum too porous to hold water; severe danger of ground water contamination.
Sand lenses and pockets in many places; moderately slow permeability in substratum.	Good to fair stability; can be compacted to high density; fair resistance to piping; variable material to depth of 36 inches.	Seasonal high water table; moderate permeability; drainage designed to intercept seepage is most likely to be successful.	Terraces and diversions not needed in some places; seasonally wet and seepy; wetness may hinder construction.	Seepy and wet; drainage needed to establish vegetation.	Severe: seasonal high water table.	Moderate: stratified with coarse material; fluctuating water table.
Moderate permeability; reservoir area needs to be compacted; a sealer may be needed to prevent excess seepage; uniform material.	Semipervious when compacted; medium to low stability when moist; subject to piping; moderate shrink-swell potential.	Not needed	Soil features favorable.	Highly erodible	Severe where slopes are more than 9 percent: moderate permeability.	Severe where slopes are more than 9 percent: semipervious if compacted.
Very shallow to fractured bedrock; too porous to hold water.	Very limited amount of material; limestone bedrock at depth of 12 inches.	Not needed	Limestone bedrock at depth of 12 inches; bedrock will hinder construction.	Limestone bedrock at depth of 12 inches.	Very severe: very shallow to limestone bedrock.	Very severe on all slopes: very shallow to fractured limestone.
Material too porous to hold water; very rapid permeability.	High seepage rate; high stability; highly erodible; poor resistance to piping; very low shrink-swell potential.	Not needed	Highly erodible; difficult to build and maintain terrace ridges and channels; vegetative cover difficult to establish where loose sandy subsoil is exposed.	Highly erodible; difficult to vegetate.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; very rapid permeability; danger of ground water contamination.	Severe on all slopes: material too porous to hold water; high seepage rate.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
393B, 393C	Poor: droughty.	Good to depth of 36 to 48 inches: unsuitable below; no sand.	Not suitable	Good: good workability; low compressibility; substratum easily compacted to high density; very low shrink-swell potential in upper part.	Highly erodible; subject to seepage in deep cuts; loose sand may hinder excavation; fair to good bearing capacity and fair shear strength below depth of 36 to 42 inches.	Low compressibility; subject to liquefaction and piping when wet; fair to good bearing capacity and shear strength in substratum; medium to low compressibility and subject to uneven consolidation in substratum.
Spillville: 485	Good to depth of 36 to 48 inches: high organic-matter content.	Fair: poorly graded sand may occur below depth of 48 to 60 inches; may contain an excess of fines.	Poor: small amount of gravel may occur below depth of 48 to 60 inches.	Poor: medium to high compressibility; high organic-matter content; difficult to compact to high density.	Subject to overflow; surface layer high in organic-matter content; poor bearing capacity and shear strength; seasonal high water table.	Subject to overflow; poor bearing capacity and shear strength; medium to high compressibility.
Steep rock land: 478G. Properties too variable to estimate.						
Stronghurst: 165A	Fair: low in organic-matter content.	Not suitable	Not suitable	Fair bearing capacity and shear strength; medium to high compressibility; difficult to compact to high density.	Seasonal high water table; moderately rapid permeability; moderate to high shrink-swell potential; fair bearing capacity and shear strength.	Medium to high compressibility; uniform consolidation; high shrink-swell potential; fair bearing capacity and shear strength.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Very rapid permeability in upper part; too porous to hold water; moderately slow permeability in substratum when compacted.	Permeable even where compacted; highly erodible; poor resistance to piping in upper part of subsoil; lower part of subsoil and substratum easily compacted to high density; moderate shrink-swell potential in substratum.	Generally not needed; hillside seepage in places; tile may be beneficial in these places.	Highly erodible; unstable on slopes; ridge and channel difficult to maintain; may expose dense low-fertility subsoils.	Highly erodible; difficult to vegetate.	Moderate where slopes are less than 9 percent; severe where slopes are more than 9 percent; very rapid permeability above substratum; danger of ground water contamination.	Moderate to severe on all slopes: material above substratum too porous to hold water; moderately slow permeability in substratum.
Nearly level topography; suitable sites unlikely; subject to flooding.	Moderate stability; moderate shrink-swell potential; poor resistance to piping; high in organic-matter content.	Subject to overflow.	Terraces not needed; all features favorable for diversions.	Not needed; all features favorable.	Moderate to very severe: subject to overflow.	Severe: semipervious when compacted; subject to overflow; moderate to severe danger of contamination.
Nearly level topography; suitable sites unlikely; reservoir bottom should be scarified and compacted; subject to seepage.	Fair stability; poor compaction above optimum moisture; medium to high compressibility.	Seasonal high water table; tile not needed in some places.	Generally not needed; if needed, soil features favorable.	Generally not needed; if needed, soil features favorable.	Moderate: seasonal high water table; moderately rapid permeability.	Moderate: moderately rapid permeability; seasonal high water table; difficult to compact to high density.

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TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Tama: 120A, 120B, 120C, 120C2.	Good to depth of 12 to 18 inches; fair below.	Not suitable	Not suitable	Fair: moderate to high shrink-swell potential; fair bearing capacity; elastic; difficult to compact properly; surface layer high in organic-matter content.	Upper layer high in organic-matter content; high moisture in some deep cuts; cuts easy to vegetate.	Medium to high compressibility; uniform consolidation; fair bearing capacity and shear strength.
T120A, T120B	Good to depth of 12 to 18 inches; fair below.	Not suitable to depth of of 48 inches; good below depth of 48 inches or more; fine and medium sand.	Not suitable	Fair: moderate to high shrink-swell potential; fair bearing capacity; difficult to compact properly; surface layer high in organic-matter content.	Surface layer high in organic-matter content, high moisture in some cuts; cuts difficult to vegetate when exposed.	Medium to high compressibility above coarse-textured material; uniform consolidation, and good bearing capacity and shear strength below depth of 48 inches.
Tell: 353B, 353C2	Good to depth of 6 to 12 inches; fair below; low organic-matter content.	Fair: poorly graded fine and medium sand below depth of 24 to 36 inches.	Poor: small amount of gravel below depth of 24 to 36 inches.	Fair to good: fair bearing capacity above substratum; good bearing capacity in substratum; very low shrink-potential; good stability when confined.	Fair bearing capacity to depth of 24 to 36 inches; good bearing capacity below; may contain free water in deep cuts; high susceptibility to frost heave in some areas.	Good bearing capacity and shear strength below depth of 24 to 36 inches; low shrink-swell potential.
Tripoli: 398	Fair in upper 18 inches; poor below.	Not suitable	Not suitable	Poor in upper 24 inches; good below; fair to good bearing capacity; easily compacted to high density; surface layer high in organic-matter content.	Seasonal high water table; surface layer high in organic-matter content; high susceptibility to frost action where water-bearing sand pockets occur: fair to poor bearing capacity and shear strength below depth of 24 inches.	Low compressibility; seasonal high water table; high susceptibility to frost heave where water-bearing sand pockets occur; fair to good bearing capacity and shear strength below depth of 24 inches.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversion	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Moderate permeability; uniform material; reservoir bottoms should be scarified and compacted; subject to seepage; sealer may be required.	Fair stability; moderate to high compressibility; moderate to high shrink-swell potential; high organic-matter content.	Not needed	Soil features favorable.	Seepy and wet in some places; tile needed on sides of waterways to control seepage and to establish suitable vegetation.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; moderate permeability.	Moderate where slopes are less than 9 percent: moderate permeability; difficult to compact to high density.
Moderate permeability to depth of 48 inches; reservoir bottoms should be scarified and compacted; coarse-textured material below depth of 48 inches; rapid permeability.	Fair stability; fair to poor compaction above optimum moisture; moderate to high shrink-swell potential.	Not needed	Soil features favorable.	Soil features favorable.	Slight where slopes are less than 5 percent: coarse-textured material below depth of 48 inches; slight to moderate hazard of contamination of ground water and streams.	Severe on all slopes: coarse-textured material below depth of 48 inches; substratum too porous to hold water.
Very rapid permeability below depth of 24 to 36 inches; too porous to hold water.	Fair stability; fair to good compaction; rapid seepage rate; poor resistance to piping.	Not needed	Coarse-textured material at depth of 24 to 36 inches; cuts should be held to a minimum to prevent exposure of coarse-textured material.	Coarse textured material at depth of 24 to 36 inches; difficult to vegetate where exposed.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; hazard of contamination.	Severe on all slopes; substratum too porous to hold water.
Nearly level topography; suitable sites unlikely; slow permeability when compacted; sand pockets or lenses in some places; surface layer high in organic-matter content.	Fair stability; impervious when compacted; moderate shrink-swell potential; surface layer high in organic-matter content.	Seasonal high water table; moderately slow permeability in subsoil.	Not needed due to topography.	Not needed due to topography.	Severe: seasonal high water table; moderately slow permeability in subsoil.	Slight: a few sand pockets or strata; surface layer high in organic-matter content.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
Walford: 160	Fair to poor: seasonal high water table.	Not suitable	Not suitable	Very poor: poor bearing capacity; difficult to compact properly; high shrink-swell potential.	Nearly level to depressional topography; seasonal high water table; seasonal ponded surface water.	Poor bearing capacity; high compressibility; uniform consolidation; seasonal high water table.
T160	Fair to poor: high water table.	Fair to good below depth of 60 inches: sand fine and medium.	Not suitable	Very poor to a depth of 60 inches: poor bearing capacity; difficult to compact properly; high shrink-swell potential. Good suitability below depth of 60 inches.	Nearly level to depressional topography; high water table; seasonal ponded surface water.	Poor bearing capacity and compressibility; uniform consolidation to a depth of 60 inches; high water table.
Wapsie: 777A, 777B	Good in upper 12 inches; fair to 12 to 24 inches; poor below.	Good below depth of 24 to 30 inches: well-graded fine to coarse sand and small amount of gravel.	Fair below depth of 30 inches: small amount of gravel.	Good below depth of 30 inches; very low compressibility; good workability; very low shrink-swell potential.	Fair bearing capacity and shear strength in upper 30 inches; good bearing capacity and shear strength below; low relief.	Fair bearing capacity and shear strength to depth of 30 inches; good bearing capacity and shear strength below depth of 30 inches; very low compressibility.
Waubeek: 771B, 771C2.	Fair to good: layer with organic-matter thin.	Not suitable	Not suitable	Fair in upper 24 to 36 inches; good below; fair to good bearing capacity below depth of 24 to 36 inches; moderate to high shrink-swell potential; easily compacted to high density.	Seepage may occur in cuts; high susceptibility to frost where sand pockets and strata occur; fair bearing capacity above depth of 24 to 36 inches; good bearing capacity below.	Fair bearing capacity and shear strength to depth of 24 to 36 inches; good bearing capacity and shear strength and low compressibility below depth of 24 to 36 inches.
Waukee: 178A, 178B	Good to depth of 12 to 18 inches: high organic-matter content. Fair to poor below depth of 12 to 18 inches.	Good: well-graded sand and gravel below depth of 36 inches.	Fair: generally small amount of gravel below depth of 36 inches.	Fair in upper 30 to 36 inches: moderate shrink-swell potential. Good below depth of 30 to 36 inches: good bearing capacity; surface layer high in organic-matter content.	Surface layer high in organic-matter content; fair bearing capacity and shear strength above depth of 30 to 36 inches.	Fair bearing capacity and shear strength above depth of 30 to 36 inches; good below; low compressibility below depth of 30 to 36 inches.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Nearly level to depressional topography; slow permeability if compacted.	Poor stability when wet; poor compaction and workability; high shrink-swell potential.	Seasonal high water table; slow permeability; subject to ponding.	Not needed due to topography.	Not needed due to topography.	Very severe: seasonal high water table; slow permeability; subject to ponding.	Moderate: surface layer moderately high in organic-matter content.
Nearly level to depressional topography; slow permeability if compacted.	Poor stability when wet; poor compaction and workability; high shrink-swell potential.	High water table; slow permeability; subject to ponding.	Not needed due to topography.	Not needed due to topography.	Very severe: high water table; slow permeability; subject to ponding.	Moderate: surface layer moderately high in organic-matter content.
Coarse-textured material at depth of 30 inches; too porous to hold water.	Good stability; easily compacted to high density above coarse-textured material; poor resistance to piping; sand and gravel below depth of 30 inches.	Not needed	Generally not needed; deep cuts will expose coarse material.	Easy to vegetate unless cuts expose coarse material.	Slight where slopes are less than 5 percent; moderate hazard of contamination of ground water and streams.	Severe: substratum too porous to hold water; danger of contamination of ground water and streams.
Moderately slow permeability; reservoir bottom should be scarified and compacted; sand pockets and lenses occur in substratum in some areas.	Fair to good stability; good compaction and workability below depth of 24 to 36 inches; moderate to high shrink-swell potential.	Generally not needed.	Soil features favorable; cuts should be held to minimum to avoid exposing low-fertility high-density glacial till below depth of 24 to 36 inches.	Seepy and wet; tile needed to control seepage and to establish vegetation.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent.	Moderate where slopes are 2 to 9 percent; moderately slow permeability below depth of 24 to 36 inches.
Sandy material at depth of 30 to 36 inches; too porous to hold water.	Fair stability in upper 30 to 36 inches; moderate shrink-swell potential; surface layer high in organic-matter content.	Not needed	Generally not needed; if needed, cuts should be held to minimum to avoid exposing sandy substratum at depth of 36 inches.	Soil features favorable.	Slight where slopes are less than 5 percent; poor filtering material in substratum; moderate hazard of contamination.	Severe: substratum too porous to hold water; moderate danger of contamination; surface layer high in organic-matter content.

TABLE 5.—*Engineering*

Soil series and map symbols	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand	Gravel	Road fill	Highway location	Foundations for low buildings
578A, 578B, 578C	Good to depth of 12 to 18 inches: high organic-matter content. Fair to poor below depth of 12 to 18 inches.	Good: well-graded sand below depth of 36 inches.	Poor: very small amount of gravel below depth of 36 inches.	Fair in upper 30 to 36 inches: moderate shrink-swell potential and fair bearing capacity. Good suitability below depth of 30 to 36 inches: good bearing capacity; surface layer high in organic-matter content.	Surface layer high in organic-matter content; fair bearing capacity and shear strength to depth of 30 to 36 inches, good bearing capacity and shear strength below depth of 30 to 36 in inches.	Fair bearing capacity and shear strength above depth of 30 to 36 inches; good below; low compressibility below depth of 30 to 36 inches.
Waukegan: 350A, 350B, 350C.	Good to depth of 12 to 18 inches; fair below.	Good below depth of 24 to 36 inches: poorly graded fine and medium sand.	Poor: small amount of gravel below depth of 24 to 36 inches.	Fair to good: fair bearing capacity above depth of 24 to 36 inches; good below; very low shrink-swell potential in substratum; good stability when confined.	Surface layer high in organic-matter content; fair bearing capacity to depth of 24 to 36 inches, good below.	Low compressibility below depth of 24 to 36 inches; good bearing capacity and shear strength.
Whalan: 207C2	Fair in upper 18 inches; poor below; limestone at depth of 24 inches.	Not suitable	Not suitable: bedrock at depth of 24 inches; suitable for crushing.	Fair to good in upper 24 inches; bedrock good if crushed.	Bedrock at depth of 24 inches; upper 24 to 36 inches of limestone is typically fractured and loose.	Bedrock at depth of 24 inches.
Whittier: 352A, 352B, 352C2.	Good to depth of 12 inches; fair below.	Good below depth of 24 to 36 inches: poorly graded fine and medium sand.	Poor: small amount of gravel below depth of 24 to 36 inches.	Fair in upper 24 to 36 inches: fair bearing capacity and medium to high compressibility. Good suitability below depth of 24 to 36 inches: very low shrink-swell potential and good stability if confined.	Free water in deep cuts in places; fair bearing capacity to depth of 24 to 36 inches good bearing capacity and shear strength below depth of 24 to 36 inches.	Low compressibility: good bearing capacity and shear strength below depth of 24 to 36 inches.

interpretations of soils—Continued

Soil features affecting—Continued					Soil limitations for sewage disposal	
Farm ponds		Drainage for crops and pasture	Terraces and diversions	Grassed waterways	Septic tank filter fields	Sewage lagoons
Reservoir areas	Embankments					
Sandy material to depth of 30 to 36 inches; too porous to hold water.	Fair stability in upper 30 to 36 inches; good stability in substratum; moderate shrink-swell potential; surface layer high in organic-matter content.	Not needed	Generally not needed; if needed, cuts should be held to minimum to avoid exposing sandy substratum at depth of about 36 inches.	Soil features favorable.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; poor filtering material in substratum.	Severe: substratum too porous to hold water; surface layer high in organic-matter content.
Coarse material at depth of 24 to 36 inches; too porous to hold water.	Fair stability; fair to good compaction; moderate shrink-swell potential; poor resistance to piping.	Not needed	Coarse-textured material at depth of 24 to 36 inches; cuts should be held to minimum to avoid exposing coarse-textured material.	Soil features generally favorable; coarse-textured material at depth of 24 to 36 inches; difficult to vegetate if exposed.	Slight to moderate where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; moderate hazard of ground water contamination.	Severe: substratum too porous to hold water.
Shallow to fractured limestone; too porous to hold water.	Shallow to bedrock; limited material available; good stability; easily compacted to high density.	Not needed	Shallow to limestone bedrock; bedrock may hinder construction.	Shallow to bedrock; bedrock may hinder construction.	Severe: limestone bedrock at depth of 20 to 30 inches; danger of ground water contamination.	Severe on all slopes; shallow to fractured limestone; danger of ground water contamination.
Coarse-textured material at depth of 24 to 36 inches; too porous to hold water.	Fair stability; fair to good compaction; poor resistance to piping.	Not needed	Coarse-textured material at depth of 24 to 36 inches; cuts should be held to minimum to avoid exposing coarse-textured material.	Soil features favorable.	Slight where slopes are less than 5 percent; moderate where slopes are 5 to 9 percent; moderate hazard of ground water contamination.	Severe on all slopes; substratum too porous to hold water.

TABLE 6.—*Engineering*

[Tests performed by Iowa State Highway Commission in accordance with standard procedures of the American

Soil name and location	Parent material	Report No. AAD6–	Depth	Moisture-density[1]	
				Maximum dry density	Optimum moisture
			In.	*Lb./cu. ft.*	*Pct.*
Aredale loam: 342 feet N. and 651 feet E. of SW. corner of NW¼ sec. 20, T. 85 N., R. 6 W. (Modal).	Loamy erosional sediment and glacial till.	3380	0–7	109	15
		3381	22–31	119	13
		3382	31–53	118	11
		3383	53–79	117	12
Bertram sandy loam: 520 feet E. and 720 feet S. of NW. corner of SE¼SW¼ sec. 1, T. 86 N., R. 6 W. (Modal).	Sandy loam over limestone.	11026	0–8	109	15
		11027	17–27	117	13
Chelsea loamy fine sand: 280 feet N. of SW. corner of SE¼ sec. 27 and 60 feet E. of fence on E. side of State Highway 13 sec. 27, T. 86 N., R. 6 W. (Modal).	Eolian sand.	1603	1–4	109	13
		1604	7–15	111	11
		1605	36–70	110	11
Colo silty clay loam: 90 feet E. of north-south ditch and 150 feet N. of east-west ditch, SW¼SW¼ sec. 8, T. 82 N., R. 8 W. (Modal).	Alluvium.	3390	0–9	84	29
		3391	22–34	97	19
		3392	52–60	102	17
Dickinson fine sandy loam: 480 feet N. and 186 feet W. of SW. corner of NW¼NW¼ sec. 5, T. 85 N., R. 6 W. (Modal).	Eolian sandy loam.	3393	0–6	119	10
		3394	19–28	114	13
		3395	33–44	120	12
Dinsdale silty clay loam: 157 feet W. of road cloverleaf and 405 feet W. of County J cloverleaf, NE¼NE¼ sec. 14, T. 84 N., R. 6 W. (Modal).	Loess and glacial till.	3387	0–7	99	20
		3388	24–30	101	20
		3389	36–44	112	14
Kenyon loam: 1,300 feet E. and 2,540 feet N. of SW. corner of SE¼ sec. 34, T. 82 N., R. 8 W. (Modal).	Loamy erosional sediment and glacial till.	3384	0–8	106	16
		3385	29–35	112	15
		3386	55–74	118	12
Klinger silty clay loam: 137 feet S. of east-west road cloverleaf and 87 feet W. of farm drive, NE¼NE¼ sec. 21, T. 84 N., R. 6 W. (Modal).	Loess and glacial till.	3396	0–12	91	24
		3397	22–30	95	17
		3398	46–57	114	14
Olin sandy loam: 150 feet E. and 150 S. of NW corner of SW¼NE¼ sec. 1, T. 86 N., R. 7 W. (Modal).	Sandy material and glacial clay.	11023	0–7	114	14
		11024	23–31	123	11
		11025	38–52	119	12
Whittier silt loam: 450 feet W. and 550 feet N. of SE corner of SE¼NW¼ sec. 26, T. 82 N., R. 6 W. (Modal).	Silty material and sand.	11020	0–8	108	15
		11021	21–32	103	19
		11022	43–55	118	10

[1] Based on AASHO Designation T 99, Method A (*1*).

[2] Mechanical analyses according to the AASHO Designation T 88 (*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for use in naming textural classes for soil.

test data

Association of State Highway Officials (AASHO). Absence of an entry indicates that no determination was made]

Mechanical analysis [2]										Liquid limit	Plasticity index	Classification	
Percentage passing sieve—						Percentage smaller than—						AASHO [3]	Unified [4]
¾ in.	⅜ in.	No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	*Pct.*			
------	------	--------	100	96	60	52	33	19	14	25	9	A-4(5)	CL
------	------	--------	100	95	41	33	22	16	13	21	8	A-4(1)	SC
------	------	--------	100	92	34	22	15	10	9	20	6	A-2-4(0)	SM-SC
100	99	99	98	86	55	49	38	27	23	33	18	A-6(7)	CL
------	------	--------	100	90	46	36	28	17	12	28	9	A-4(2)	SM
------	100	99	98	85	41	37	27	19	16	22	7	A-4(1)	SM
------	------	--------	100	97	16	15	8	5	3	--------	[5] NP	A-2-4(0)	SM
------	------	--------	100	98	13	11	7	4	4	--------	([5])	A-2-4(0)	SM
------	------	--------	100	97	8	6	5	2	2	--------	([5])	A-3(0)	SM-SP
------	------	--------	--------	100	97	92	74	47	37	65	31	A-7-5(20)	OH-CH
------	------	--------	100	99	92	86	76	52	44	63	40	A-7-6(20)	CH
------	------	--------	100	98	91	87	69	44	36	51	32	A-7-6(18)	CH
------	------	--------	100	92	39	31	20	13	9	18	4	A-4(1)	SM-SC
------	------	--------	100	95	58	49	33	21	17	23	7	A-4(5)	CL-ML
------	------	--------	100	89	20	14	10	8	6	--------	([5])	A-2-4(0)	SM
------	------	--------	100	99	90	77	53	31	23	37	15	A-6(10)	ML-CL
------	------	--------	100	97	83	73	55	33	29	40	19	A-6(12)	CL
100	99	99	99	89	58	50	40	29	24	33	19	A-6(8)	CL
------	------	--------	100	95	71	64	41	24	18	30	10	A-4(7)	CL
------	------	100	99	90	57	50	43	29	26	34	19	A-6(8)	CL
100	98	98	97	88	56	48	40	27	23	30	17	A-6(7)	CL
------	------	--------	100	99	96	89	61	35	25	42	16	A-7-6(11)	ML-CL
------	------	--------	100	99	96	87	60	40	34	46	22	A-7-6(14)	CL
------	100	99	98	88	58	50	40	29	25	33	18	A-6(8)	CL
------	------	--------	100	90	46	39	31	19	13	25	6	A-2-4(0)	SM
------	------	--------	100	86	34	29	23	14	11	17	3	A-2-4(0)	SM or SP
------	100	99	98	89	49	48	36	27	24	28	13	A-6(4)	SC
------	100	99	99	97	85	76	51	22	16	28	7	A-4(8)	CL-ML
------	------	--------	--------	100	98	91	66	41	36	43	20	A-7-6(13)	CL
------	------	--------	100	96	16	13	11	11	10	15	0	A-3(0)	SM

[3] Based on AASHO Designation M 145-49 (*1*).
[4] Based on the Unified Soil Classification System (*18*).
[5] NP=Nonplastic.

Embankments require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among the factors that are unfavorable.

Drainage for crops and pasture is affected by such soil properties as permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Terraces and diversions are embankments, or ridges, constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

Grassed waterways are vegetated channels that conduct runoff, at a nonerosive velocity, to a stable outlet. Many of the waterways in the county are gullied and are lined with trees and brush. Large quantities of earth will have to be moved from these areas before the channels can be properly shaped. If the waterways are shaped and velocity of runoff is reduced, the soils are generally fertile enough to grow vegetation to help control erosion. In most places tile lines are needed on both sides of the shaped waterway to permit the grass to become established and to reduce wetness so that the waterway can be crossed by machinery.

Septic-tank filter fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and susceptibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor, and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are considered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, content of organic matter, and slope, and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material as interpreted from the Unified Soil Classification and the amounts of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Soil test data

Table 6 contains engineering test data for some of the major soil series in Linn County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material increases until the *optimum moisture content* is reached. After that, density decreases as moisture content increases. The highest dry density obtained in the compactive test is termed *maximum dry density*. As a rule, maximum strength of earthwork is obtained if the soil is compacted to the maximum dry density.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The *plastic limit* is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The *plasticity index* is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Soil features affecting highway work[3]

The soils in Linn County that affect roadbuilding formed mainly in glacial till, loess, and alluvium. However, limestone bedrock is exposed along many of the stream valleys in the county. The glacial till is rock debris that principally is sandy and clayey and contains pebbles and boulders; there are occasional pockets and strata of sand and gravel. The glacial till has a maximum thickness of about 300 feet, but this thickness varies. Loess, or wind-blown silt, mantles the glacial till in parts of the county. The thickness of loess varies considerably. In general, the loess is thickest in the areas adjacent to the Cedar and Wapsipinicon Rivers (fig. 10).

The glacial till in Linn County has relatively high in-place density. It is relatively stable at any moisture content and can be compacted readily to high density. The textural composition varies, but where the material is dry, there are enough fines and coarse material to provide a firm riding surface with little rebound after loading. The glacial till has good bearing capacity if loosened and compacted to maximum practical density, but it loses this bearing capacity when moisture is absorbed.

Soils such as Bassett, Coggon, Kenyon, Oran, Readlyn, and Tripoli are the dominant soils that formed in glacial till. The texture of these soils are loam, clay loam, and sandy clay loam and are classified as A–6 or A–4. Pockets and lenses of sand are commonly in these soils and in

[3] By DONALD A. ANDERSON, soil engineer, Iowa State Highway Commission.

Figure 10.—Deep road cut in loess adjacent to Cedar River.

many places are water bearing. Where the road grade cuts through such deposits, frost heaving is likely unless the sandy soil material is drained or the material above it is replaced with a granular backfill or with the more uniform clayey subsoil till. These soils are a good source of material for highway subgrades.

The Atterberry, Downs, Fayette, Garwin, Muscatine, Seaton, Tama, and Walford are the dominant loess-derived soils. These soils are silt loam and silty clay loam in texture and are classified dominantly as A–7 except in the surface layer. These soils have relatively high group index numbers. The Garwin, Muscatine, and Tama soils have highly organic surface layers and are difficult to compact to good densities; these surface layers are unsuitable for subgrade. The subsoil of these soils is mainly silty clay loam in texture, but the Seaton soils have a subsoil of silt loam. These materials lose stability under wheel loads if they are saturated, and they do not make a desirable upper subgrade in cut areas where moisture content is high. These loessial soils erode readily if runoff is concentrated. Sodding, paving, or building check dams is needed in places in gutters and ditches to prevent excessive erosion.

The soils on bottom lands formed in recent alluvium washed from hills and uplands. Such soils as the Colo, Ely, Judson, Kennebec, Lawson, Nodaway, and Spillville have a thick, organic surface layer that may consolidate erratically under an embankment load. These soils have low in-place density and strength. Therefore, if an embankment is to be more than 15 feet in height, these soils should be carefully analyzed to be sure that they are strong enough to support it. Roadways through bottom lands should be constructed on a continuous embankment that extends above the flood level.

Limestone underlies the glacial till and loess, and in places outcrops are on the surface layer. The dominant soils that are shallow to bedrock in Linn County are the Bertram, Dodgeville, Rockton, Sogn, and Whalan. The thin residual subsoil of these soils just above the rock is undesirable for use in the upper subgrade because of its high clay content and non-uniform characteristics. However, this residual material is generally less than 1 foot thick and is discontinuous over the limestone. In areas where the limestone is not deeply buried below the glacial till or loess, sinkholes have developed, leaving depressions. These sinkholes do not provide enough support for the embankment for roadways or for other structures. Therefore, great care is needed to determine their location and extent during preliminary investigations.

The Burkhardt, Chelsea, Dickinson, Flagler, Hayfield, Lamont, Lawler, Marshan, Sattre, Saude, Sparta, Tell, Wapsie, Waukee, Waukegan, and Whittier soils all formed in sandy material or have sandy material at a depth of about 2 to 3 feet. These soils are possible sites for borrow for road construction. However, in the Chelsea, Dickinson, Lamont, Sparta, Tell, and Whittier soils the sand is fine grained and poorly graded and lacks gravel. The Burkhardt, Flagler, Hayfield, Lawler, Marshan, Sattre, Saude, Wapsie, Waukee, and Waukegan soils offer the most potential for source areas of gravel. In the Hayfield, Lawler, and Marshan soils the high water table at times interferes with excavation, and pumping is needed.

Included in table 5 are ratings that show the suitability of the soils of the county as a source of topsoil that can be used to promote the growth of vegetation on embankment and in cuts on slopes and in ditches, and as a source of borrow for road construction.

Nonfarm Uses of the Soils

This section is mainly for owners of land who plan to put in septic-tank filter fields or build homes. It can also be used by planners, developers, and zoning officials. Table 5 rates the soils for septic-tank filter fields and sewage lagoons. A rating of *slight* means that the soil features are favorable. The soil is relatively free of limitations or has limitations that are easy to overcome. *Moderate* limitations require careful management to overcome. *Severe* limitations require extreme measures to overcome. *Very severe* limitations require very extreme measures to overcome.

When homes are built in the county, especially away from sewer lines, septic tanks and systems to dispose of effluent are needed. The characteristics that affect the limitations for septic-tank filter fields are as follows: soil permeability, percolation rate, ground water level, hazard of flooding, natural drainage, landscape position, slope, and depth to bedrock and coarse-textured sand and gravel.

The rate at which effluent moves through a soil depends partly on the texture of the subsoil and underlying material. Water moves faster through coarse-textured sandy and gravelly soils than through fine-textured clayey soils. In an effective system, the permeability of the soil should be moderate to rapid and the rate of percolation should be at least 1 inch per hour. If there is any doubt about the absorptive ability of the soil where a filter is planned, a percolation test should be made (*17, 19*).

If ground water rises to the level of the subsurface tile in the filtering field, the soil is so saturated that it will not take the effluent from the septic tank. The effluent may rise to the surface layer, giving off a bad odor and endangering health. The water table should be at a

depth of at least 4 feet below the surface during the wettest periods for maximum efficiency. Generally, well-drained soils are satisfactory for these disposal systems and poorly drained soils are not.

A disposal system for septic tanks should never be on a flood plain or near a stream that is likely to flood. An occasional flooding over the filter field impairs its efficiency, and frequent floods soon destroy its effectiveness. In many areas, local regulations require that the filter field be located 25 to 50 feet from a stream, lake, open ditch, or other watercourse into which unfiltered and contaminated effluent might enter and spread.

Bedrock (fig. 11), clay layers, or other impervious strata should be at a depth of more than 4 feet below the bottom of the trench in the filter field so that there is enough soil to filter and purify the effluent. Even more depth is needed if the domestic water supply comes from wells and the bedrock is limestone. Limestone has many cracks, and unfiltered water may seep into the domestic water supply if the soil is not deep enough. Also, a depth of more than 4 feet is needed if the underlying material is sand and gravel. A disposal system works very well in a sandy soil, but if the supply of domestic water comes from a shallow source, effluent may contaminate the water.

If other characteristics of a soil are favorable for the function of filter fields, a slope of up to 9 percent is satisfactory. The filter beds are easier to construct and maintain in level areas or on gently sloping areas than they are on steeper areas. In steeper areas the effluent may follow the natural drainage lines through the soil or seep out to the surface layer before it is properly filtered. Tile lines for the system should be placed on the contour to assist in filtering the effluent.

The Aredale, Bertrand, Dinsdale, Fayette, Tama, and Waubeek soils have characteristics that are favorable for septic-tank filter fields. They are moderately well drained to well drained, they have moderate to moderately slow permeability, and the water table is not close to the surface. Since slope is an important factor, these soils increase in degree of limitation from slight to moderate or severe as the slope increases. The moderately well drained Kenyon and Bassett soils have a moderate limitation where slopes are less than 9 percent that increases to severe where slopes are more than 9 percent. These soils have questionable percolation rates.

Figure 11.—**Soils that have fractured limestone this close to the surface are not suitable for filtering and purification of effluent. This soil is in the Dodgeville series.**

The somewhat poorly drained Atterberry, Franklin, Klinger, and Muscatine soils have moderate limitations because of a seasonal high water table and moderate to moderately slow permeability. Floyd, Oran, Readlyn, and Schley soils also are somewhat poorly drained and have moderate to severe limitations on all slopes. These soils have a seasonal high water table, and the percolation rates are questionable for the Oran and Readlyn soils. The Hayfield and Lawler soils also are somewhat poorly drained and have moderate limitations but have a sand and gravel substratum. The danger of contamination of the ground increases for these two soils because of the underlying coarse-textured material. The Clyde, Colo, Garwin, Marshan, Maxfield, and Tripoli soils occur in depressions or drainageways and are poorly drained. These soils have severe to very severe limitations.

The Bertram, Dodgeville, Rockton, Sogn, and Whalan soils have moderate to very severe limitations because of limestone bedrock. Contamination of the ground water by the septic-tank effluent is also a danger.

The Ely, Kennebec, Lawson, Nodaway, and Spillville soils and Loamy alluvial land are subject to periodic overflow. Their limitations for use as filter fields are moderate to very severe, depending on the frequency of flooding or runoff from higher elevations. Muck has very severe limitations because of the high content of organic matter and high water table.

Some sandy soils, such as the Burkhardt, Chelsea, Dickinson, Flagler, Lamont, and Sparta soils, have slight to moderate limitations where slopes are less than 9 percent and severe limitations where slopes are more than 9 percent. But the hazard of contaminating the ground water supply is severe because the sandy or gravelly material allows the effluent to travel long distances.

Before designing and constructing a disposal system for septic tanks, one should become familiar with the regulations, requirements for permits, and inspection systems. The City and County Planning Commission, the local Board of Health, the Agricultural Extension Director, and State and Federal Departments of Health can offer help.

Many communities are using lagoons as a method for disposing of sewage without polluting streams. The soil properties considered are permeability, depth to bedrock, slope, texture, and content of organic matter.

The moderately well drained to well drained Dinsdale, Downs, Fayette, and Tama soils have favorable soil characteristics and have only slight limitations where slopes are less than 2 percent. The degree of limitation increases as the slope increases.

The Atterberry, Floyd, Franklin, Klinger, Muscatine, Oran, Readlyn, and Schley soils have slight to moderate limitations. They have a seasonal high water table, have high content of organic matter, and are somewhat poorly drained. The Hayfield and Lawler soils also are somewhat poorly drained and have severe limitations because

of the sand and gravel in the substratum. This material is too porous to hold liquids.

The poorly drained Clyde, Colo, Garwin, Marshan, Maxfield, and Tripoli soils have moderate to severe limitations. These soils receive runoff or are subject to overflow. The Marshan soils have sand and gravel in the substratum, which is too porous to hold liquids.

The Ely, Judson, Kennebec, Lawson, Nodaway, and Spillville soils and Loamy alluvial land have moderate to very severe limitations. All are either subject to runoff from soils at higher elevations or are frequently flooded. The soil material in Loamy alluvial land is so variable that the material used in the lagoons might be too pervious.

The sandy Burkhardt, Chelsea, Dickinson, Flagler, Lamont, and Sparta soils have severe limitations. The texture of these soils is too coarse and permeability is too rapid to hold any liquids. The Bertram, Dodgeville, Rockton, and Whalan soils are underlain by limestone bedrock and also have severe limitations.

It is important to know the soil and slope before constructing any type of residential or industrial building, particularly where basements are to be constructed. Soil characteristics that should be considered are shear strength, shrink-swell potential, compressibility, consolidation characteristics, susceptibility to liquefaction and piping, soil texture and permeability, depth to bedrock, depth to water table (seasonal or permanent), and susceptibility to sliding. The soil features affecting the foundations for low buildings are given in table 5. Other characteristics to be considered are drainage, hazard of flooding, landscape position, and slope.

Subsurface drainage is needed on soils that have a seasonal high water table to make the soils suitable as sites for buildings. If the water table is close to the surface most of the year, the construction of basements is especially difficult. Both surface and subsurface drainage should be considered. A soil that has a permanently high water table requires a different kind of drainage than a soil having a seasonally high water table. Soils in rolling areas require still another kind of drainage. Soils that are periodically wet or frequently flooded (fig. 12) are generally not satisfactory as sites for buildings if basements are to be constructed. More suitable soils have a water table at a greater depth. The depressional areas are also not favorable, because of the large amount of fill needed to improve drainage.

Landscape positions and slopes are important too. Convex slopes are more desirable than concave slopes or drainageways positions. Some slope is desirable, but runoff from higher places may require that the excess water be channelled away from the buildings. In steeper areas, measures to stabilize banks and buildings may be needed.

Bedrock is another feature to consider. If a basement is constructed where there is limestone close to the surface, the removal of the limestone adds to the cost.

Formation and Classification of Soils

In this section, factors that affected the formation of the soils in Linn County are discussed. Also discussed is the classification of the soils by higher categories.

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on material deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil formation have acted on the soil material (*3*).

Climate and vegetation are the active factors in soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly

Figure 12.—Flooding along Prairie Creek. Colo and Spillville are the main soils flooded.

change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Time is needed for the changing of parent material into a soil profile. It may be much or little, but some time is required for horizon differentiation. A long period generally is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil formation are unknown.

Parent material

The accumulation of parent materials is the first step in the formation of a soil. Some of the soils in the county formed as the result of weathering of bedrock. Most of the soils, however, formed in material that was transported from the site of the parent rock and redeposited at a new location through the action of a glacial ice, water, wind, and gravity.

The principal parent materials in Linn County are glacial drift, loess, alluvium, and eolian, or wind-deposited, sand. Much less extensive parent materials are organic deposits and residuum.

Glacial drift is all rock material in transport by glacial ice, all deposits made by glacial ice, and all deposits dominantly of glacial origin made in the sea or in bodies of glacial melt water. It includes glacial till. Glacial till is an unsorted sediment whose particles range from the size of boulders to the size of particles (*9*). Glacial drift is the most important parent material in Linn County. At least twice during the glacial period, continental ice or glaciers moved over the land. The record of these ice invasions is contained in the unconsolidated rock material that was deposited by the melting ice and meltwater streams. The older ice sheet, known as the Nebraskan, occurred some 750,000 years ago (*4*). It was followed by the Aftonian interglacial period. The Kansan Glaciation is thought to have started about 500,000 years ago. A more recent glaciation was recognized by Leighton (*5*) as the Iowan substage of the Wisconsin Glaciation, but recent studies of the presence and identification of Iowan glacial till indicate that the conclusions formed from studies made before 1960 are questionable. Intensive, detailed, geomorphic, stratigraphic work shows that the landscape is a multilevel sequence of erosion surfaces, and that many of the levels are cut into Kansan and Nebraskan till. Ruhe's study in the vicinity of Alburnett (*8*) demonstrated that the Iowan till does not exist, but that an erosion-surface complex does exist in the Iowan region. The Iowan surface is multilevel and is arranged in a series of steps from major drainageways toward bounding divides. The Iowan surface is marked where it cuts Kansan and Nebraskan till by a stone line. The stone line occurs on all levels of the stepped surfaces where they occur, and it passes under the alluvium along the drainageways.

The soils that formed in the glacial drift and glacial till on the Iowan erosion surface are the Bassett, Clyde, Coggon, Donnan, Floyd, Kenyon, Oran, Readlyn, Schley, and Tripoli. They have a loamy surficial sediment about 1 to 2 feet thick over the glacial material. However, this is deeper in the lower concave slopes and waterways in such soils as the Clyde, Floyd, and Schley. A stone line or pebble band commonly separates the friable loamy surficial sediment from the firm loam or clay loam glacial till (fig. 13). The Donnan soils formed in loamy material and the clayey paleosol derived from glacial till.

Loess is the second most important parent material in Linn County. It is a wind-blown silt that mantles the glacial drift in parts of the uplands. Unweathered loess is silt loam in texture and is calcareous. Thickness of the loess is quite variable in Linn County. In parts of the county there is no loess mantling the glacial till. In general, the thickness of the loess is greatest along the Cedar and Wapsipinicon Rivers. The general soil map at the back of this survey shows that the largest areas of loess-derived soils are in the southern half of the county and along the major streams.

Many elongated ridges are oriented in northwesterly to southeasterly direction and are called pahas (*11*, *12*). These loess-capped ridges stand apart on the Iowan plain or merge with similar features to form long ridges or broad plateaus.

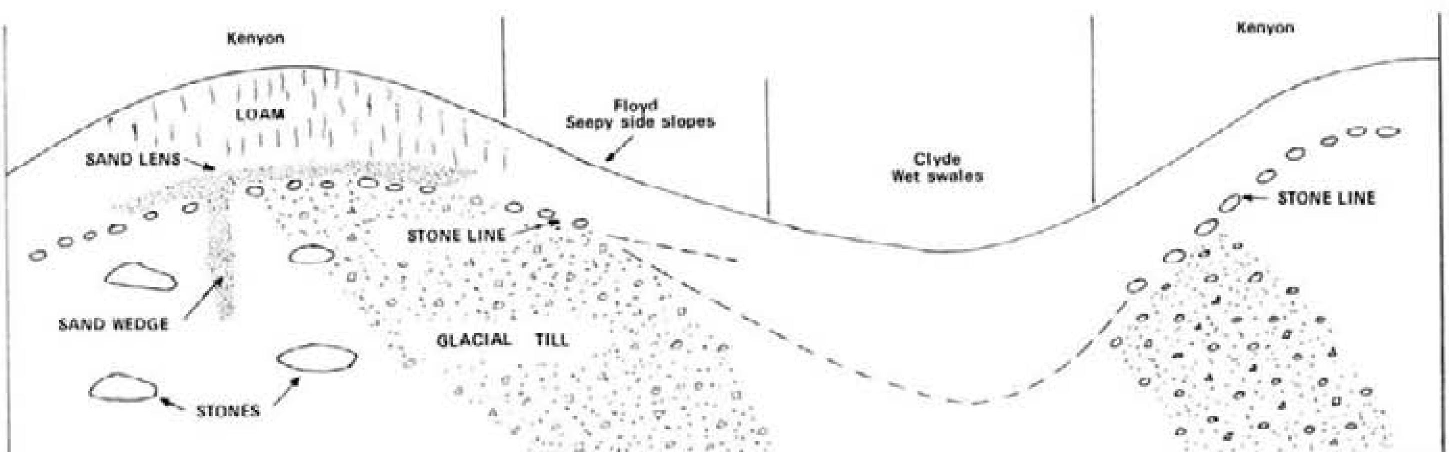

Figure 13.—Parent materials of Kenyon, Floyd, and Clyde soils.

There is a paha just north of Alburnett that is very prominent and is surrounded by nearly level to gently sloping topography. Ruhe's 1968 study states that on the summit of the paha, which is 975 feet in elevation, there is 44 feet of Wisconsin loess over Kansan till. The elevation just north of the paha is 900 feet and is devoid of loess.

The Tama, Downs, Seaton, and Fayette soils formed in areas where the loess is more than 40 inches thick. In areas where the loess is 20 to 40 inches thick over glacial till, the Dinsdale, Klinger, Maxfield, and Waubeek soils formed.

Alluvium consists of sediment that has been removed and laid down by water. These alluvial deposits of Late Wisconsin age occur under the flood plains and terraces of water courses in Linn County. These materials are lenses and layers of sand, gravel, silt, and clay. The thickness of alluvial material is variable. Along major streams these materials are as much as 95 feet thick; along small streams they are less than 5 feet thick. The Waukee soils formed in loamy alluvium over sand and gravel, while the Bertrand soils formed in silty material that has some stratified sand at a depth of about 4 feet.

Some of the alluvial material has been transported only a short distance and has accumulated at the foot of the slope on which it originated. This material is called "local" alluvium and retains many characteristics of the soils in the areas from which it has eroded. The Judson soil is an example of this and occurs at the foot of the slopes directly below loess-derived soils.

When streams overflow their channels and water spreads over the flood plains, the coarse-textured materials are deposited first. While the floodwater continues to spread, it moves more slowly, and fine-textured sediments such as silt are deposited. After the flood has passed, the finest particles, or clay, settle from the water that is left standing in the lowest part of the flood plain. The Kennebec and Nodaway soils formed from silty material, while the Spillville soils formed from coarser textured, loamy material. The Colo soils, which are on the lowest part of the flood plain, are silty clay loam, and they contain more clay.

Eolian sand, or wind-deposited sand, occurs in the uplands and on benches. In the glacial till uplands the sand occurs as low mounds or dunes and is underlain by till at varying depths. The sand also occurs in areas intermingled with the loess soils. The wind-deposited sand consists largely of quartz that is fine or very fine in size and is highly resistant to weathering. It has not altered appreciably since it was deposited. The soils in Linn County that formed mainly in wind-deposited sand are the Dickinson, Lamont, and Sparta.

Organic deposits consist of plant material that has accumulated in old lakebeds or swamps that supported a thick growth of water-loving plants. The organic soils are in small, wet areas in the county where poor drainage has retarded the decay of plant remains that have accumulated over a period of time. In Linn County the thickness of the organic material ranges from about 10 to 60 inches, but there are a few areas that are more than 60 inches in thickness. Muck soils formed in this organic material.

Residuum, the material derived from the weathering of sedimentary rock in place, is a very minor source of parent material in this county. The underlying bedrock belongs to the Cambrian, Ordovician, Silurian, and Denovian systems. These strata, composed of sandstone, limestone, dolomite, and shale, are stacked one on the other in layers. They are not level, but generally slope about 20 feet per mile to the southwest (*2*). The Silurian system outcrops or is immediately below the glacial drift. It covers most of the eastern one-third of the county (fig. 14). The Devonian system forms a large part of the bedrock in the western two-thirds of the county.

Figure 14.—Limestone outcrop along Wapsipinicon River.

Climate

According to available evidence, the soils of Linn County have been forming under the influence of a midcontinental, subhumid climate for at least 5,000 years. Between 5,000 and 16,000 years ago, the climate was conducive to the growth of forest vegetation (*6*). The morphology of most of the soils in the county indicates that the climate under which the soils formed is similar to the present one. At present, the climate is fairly uniform throughout the county but is marked by wide seasonal extremes in temperature. Precipitation is distributed throughout the year.

Climate is a major factor in determining what soils form from the various parent materials. The rate and intensity of hydrolysis, carbonation, oxidation, and other important chemical reactions in the soil are influenced by climate. Temperature, rain, relative humidity, and length of the frost-free period are important in determining the vegetation.

The influence of the general climate of the region is somewhat modified by the local conditions in or near the developing soil. For example, south-facing, dry, sandy slopes have a local climate or microclimate that is warmer and less humid than the average climate of nearby areas. Low-lying, poorly drained areas are wetter and colder than most areas around them. These contrasts account for some of the differences in soils within the same general climatic region.

Plant and animal life

All living organisms are important to soil formation. They include vegetation, animals, bacteria, and fungi. The vegetation is responsible for the content of organic matter, color of the surface layer, and the content of nutrients. Animals such as earthworms and burrowing animals help to keep the soil open and porous. Bacteria and fungi decompose the vegetation, thus releasing nutrients for plant food.

Most soils in Linn County formed under prairie grasses or a mixture of prairie grasses and water-tolerant plants. Because the grasses have many roots and tops that have decayed on or in the soils, the soils that formed under these conditions have a thick, dark surface layer. The Floyd and Kenyon soils are examples.

The soils that formed under timber vegetation have a thinner, lighter colored surface layer. The organic matter, derived principally from leaves, was deposited only on the surface layer of the soil. The Coggon and Fayette soils are examples of these light-colored soils.

In many areas a number of soils first formed under prairie grasses and then under forest vegetation. These soils are intermediate between those soils that formed entirely under grass and those under trees. The Downs and Waubeek soils are examples.

The Downs, Fayette, and Tama soils are members of a group of soils that formed in the same parent material and under a comparable environment except for native vegetation. Differences in native vegetation account for the main differences in morphology of soils of this group.

Man changes soil to meet his needs. Important changes take place in the soil when it is cultivated. Some of the changes have little influence on soil productivity, but other changes have drastic effects.

Relief

Relief, or topography, influences soil formation mainly through its effect on drainage, runoff, and erosion. In Linn County the relief ranges from level to very steep. Water soaks into the nearly level soils in areas that are not flooded. Where the slope is steeper, more water runs off the surface layer and less penetrates the soil. The Dinsdale, Klinger, and Maxfield soils are examples of soils that formed in the same kind of parent material under similar vegetation, but they differ because of topographic position. The Maxfield soils are level or nearly level on broad high upland flats. The Klinger soils are on nearly level ridges and long, gentle, concave slopes. The Dinsdale soils are gently sloping to moderately sloping on uplands.

In depressions where water is collected and impounded for a period of time, the soils are poorly drained and have a distinct, lighter colored subsurface layer and a gray subsoil. The Walford soils are examples of soils that formed in depressions.

Soils that are steeply sloping have weak soil formation. Most of the water that falls on them runs off. The Sogn soils are an example of such soils.

Soils that formed in alluvium, such as the Colo, Spillville, and Lawson, are on bottom lands. Even though they are nearly level, their microrelief affects runoff, depth to water table, and the amount of new sediment. The Colo soils are at low elevations, have a high water table, and impound water for short periods. The Lawson soils are at slightly higher elevations, but they are somewhat poorly drained.

Aspect, as well as the gradient, has a significant influence. South-facing slopes generally are warmer and drier than north-facing slopes, and consequently they support a different kind and amount of vegetation.

The influence of a porous, rapidly permeable parent material may override the influence of topography. The Dickinson soils, for example, are somewhat excessively drained, even though they are nearly level to strongly sloping, because they have moderately rapid to rapid permeability.

Time

The length of time that the soil material remains in place and is acted on by the soil-forming processes affects the kind of soil that forms. Older or more strongly developed soils show well-defined genetic horizons. The Downs, Fayette, and Tama soils are examples. A less well developed soil shows only weakly developed horizons. Some soils formed in alluvium show little or no profile development because fresh material is deposited periodically. The materials have not been in place long enough for the climate and vegetation to produce well-defined genetic horizons in the profile. The Nodaway soil is an example of a very young soil. In steep areas, soil material is removed before it has had time to develop into a deep soil profile. The Sogn soils and some of the Seaton soils are examples of this condition.

Another factor that may modify the effect of time is the resistance of materials. Soils that formed in material resistant to weathering, such as quartz sand, do not change much with time. The Chelsea and Sparta soils are examples.

Where such organic materials as trees have been buried by later deposition through the action of ice, water, or wind, the age of a landscape can be determined by a process known as radiocarbon dating (*7*).

The loess in which the Downs, Fayette, Seaton, and Tama soils formed is probably 14,000 to 20,000 years old. Recent studies by Ruhe and others (*8*) show that the Iowan erosion surface formed during loess-deposition time. The Iowan surface beneath the loess could be as young as 14,000 years, which dates the end of the major loess deposition in Iowa. The surface not covered by loess can also be younger than the loess. The Iowan surface, where it is covered by loam surficial sediment, is younger than 14,000 years, and soils on the slopes are probably much younger. Soils such as the Aredale, Bassett, Kenyon, Readlyn, and Tripoli are on this surface. The Clyde, Floyd, and Schley soils are younger, because they are cut in and below these higher lying soils.

Man's Influence on the Soil

Important changes took place when man settled Linn County. Some had little effect on soil productivity, and others had drastic effects.

Changes caused by water erosion are the most important. Cultivation changes the soil by making the sloping areas of soils more susceptible to erosion, which removes the topsoil, organic matter, and plant nutrients. Sheet erosion, which is the most prevalent in this county, re-

moves a few inches of topsoil at a time, but cultivation generally destroys all evidence of this loss. In other places, shallow and deep gullies have formed, depositing the eroded materials on the lower slopes.

When man cultivates the soil, soil blowing becomes active. The light-textured soils blow, especially when the soils are left bare and the topsoil is dry. On the nearly level fields that have been plowed in fall, dark topsoil can be seen mixed with the snow or piled along the fencerows and road ditches.

In fields that have had continuous cultivation, the well-developed granular structure of the surface layer, so apparent in virgin grassland, begins to break down. The surface layer tends to bake and become hard when dry. The fine-textured soils that have been plowed continuously when wet tend to puddle and are less permeable than similar soils in undisturbed areas. In some fields of finer textured soils, a compact layer that hardens on drying and is less permeable than the subsoil has formed below the plowed layer. This layer is called a plow sole, or plowpan.

Man has also done much to increase productivity and to reclaim areas that are not suitable for crops. He has established drainage ditches and diversions at the foot of slopes to prevent flooding of the lowlands, which can now be used for cultivated crops. He has also added commercial fertilizers to counteract deficiencies in plant nutrients so that the soil can be made more productive than the virgin soil. In many places, dark-colored, low-lying soils have received lighter colored deposition.

In Linn County a soil formed in recent alluvium that shows the influence of man is Nodaway silt loam. There are strata of light- and dark-colored materials that washed from the hillsides and were deposited by floods. This erosion has taken place since man began cultivating the hillsides.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used for classifying soils was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study (*13*, *15*). Therefore, readers interested in developments of this system should search the latest literature available. In table 7 some of the classes in the current system are given for each soil series. The classes in the current system are briefly defined in the following paragraphs.

TABLE 7.—*Classification of soil series*

Series	Current system		
	Family	Subgroup	Order
Aredale	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Atterberry	Fine-silty, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Bassett	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Bertram	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Bertrand	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Burkhardt	Sandy, mixed, mesic	Typic Hapludolls	Mollisols.
Chelsea	Sandy, mixed, mesic	Alfic Udipsamments	Entisols.
Clyde	Fine-loamy, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Coggon	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Colo	Fine-silty, mixed, noncalcareous, mesic	Cumulic Haplaquolls	Mollisols.
Dickinson	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Dinsdale	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Dodgeville [1]	Fine-silty over clayey, mixed, mesic	Typic Argiudolls	Mollisols.
Donnan	Fine-loamy over clayey, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Downs	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Ely	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Fayette	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Flagler	Coarse-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Floyd	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Franklin	Fine-silty, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Garwin	Fine-silty, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Hayfield	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kenyon	Fine-loamy, mixed, mesic	Typic Hapludolls	Mollisols.
Klinger	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Lamont	Coarse-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.

See footnote at end of table.

TABLE 7.—*Classification of soil series*—Continued

Series	Current system		
	Family	Subgroup	Order
Lawler	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Aquic Hapludolls	Mollisols.
Lawson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Marshan [2]	Fine-loamy over sandy or sandy-skeletal, mixed, noncalcareous, mesic.	Typic Haplaquolls	Mollisols.
Maxfield	Fine-silty, mixed, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Muscatine	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Nevin	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Nodaway	Fine-silty, mixed, nonacid, mesic	Typic Udifluvents	Entisols
Olin	Coarse-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Oran	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Readlyn	Fine-loamy, mixed, mesic	Aquic Hapludolls	Mollisols.
Richwood	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Rockton	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sattre	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Mollic Hapludalfs	Alfisols.
Saude	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Schley [3]	Fine-loamy, mixed, mesic	Udollic Ochraqualfs	Alfisols.
Seaton	Fine-silty, mixed, mesic	Typic Hapludalfs	Alfisols.
Sogn [4]	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Sparta	Sandy, mixed, mesic	Entic Hapludolls	Mollisols.
Spillville	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Stronghurst	Fine-silty, mixed, mesic	Aeric Ochraqualfs	Alfisols.
Tama	Fine-silty, mixed, mesic	Typic Argiudolls	Mollisols.
Tell	Fine-silty over sandy or sandy-skeletal, mixed, mesic	Typic Hapludalfs	Alfisols.
Tripoli	Fine-loamy, mixed noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Walford	Fine-silty, mixed, mesic	Mollic Ochraqualfs	Alfisols.
Wapsie	Coarse-loamy over sandy or sandy-skeletal, mixed, mesic	Mollic Hapludalfs	Alfisols.
Waubeek	Fine-silty, mixed, mesic	Mollic Hapludalfs	Alfisols.
Waukee	Fine-loamy over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Waukegan	Fine-silty over sandy or sandy-skeletal, mixed, mesic	Typic Hapludolls	Mollisols.
Whalan	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Whittier	Fine-silty over sandy or sandy-skeletal, mixed, mesic	Molic Hapludalfs	Alfisols.

[1] These soils are called Dodgeville because they are similar to the soils of the Dodgeville series, but they lack a clay or silty clay loam texture, 6 inches thick or more, in the lower part of the solum.

[2] In Linn County, Marshan silty clay loam, deep, soils are taxadjuncts to the Marshan series because most of the soils lack a contrasting texture of sand and gravel at a depth of less than 40 inches.

[3] In Linn County, Schley soils are taxadjuncts because the dominant colors in the B horizon have a chroma of 2, and there is no IIB horizon as is required in the concept of the Schley series.

[4] In Linn County, Sogn soils are taxadjuncts because they have a more favorable moisture relationship than is considered typical for the series.

ORDERS: The 10 orders recognized are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Mollisol).

The three orders represented in Linn County are Alfisols, Entisols, and Mollisols. Alfisols have a clay-enriched B horizon that is high in base saturation. Entisols are recent soils. They do not have genetic horizons, or they have only the beginning of such horizons. Mollisols have a thick surface layer that is darkened by organic matter.

SUBORDERS: Each order is subdivided into suborders, primarily on the basis of those characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of wetness or soil differences resulting from climate or vegetation. The names of suborders have two syllables, and the last syllable indicates the order. An example is Udoll (*ud*, meaning humid, and *oll* from Mollisol).

GREAT GROUPS: Soil suborders are divided into great groups on the basis of uniformity in kind and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus has accumulated or those in which pans interfere with the growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplldalf (*hapl*, meaning simple, *ud* for humid, and *alf* from Alfisol).

SUBGROUPS: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and the others, called intergrades, which have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properies intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Hapludalf.

FAMILIES: Families are differentiated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. The family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names of texture, mineralogy, etc. that are used as family differentiae. An example is the fine-loamy, mixed, mesic family of Typic Hapludalfs.

SERIES: The series consists of a group of soils that formed in a particular kind of parent material and have genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

New soil series must be established, and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program across the county. A proposed new series has tentative status until review of the series concept at national, State, and regional levels of responsibility for soil classification results in a judgment that the new series should be established. The soils are given the name of a geographic location near the place where that series was first observed and mapped. Examples are the Bertram, Coggon, and Whittier series. These names were derived from towns in Linn County.

Additional Facts About the County

This section is presented for those who are not familiar with Linn County. It describes briefly the history, climate, relief and drainage, farming, and transportation, industries, and markets.

History

The area that became Linn County was acquired by the United States as part of the Louisiana Purchase in 1803. In 1832 and in 1837 the Linn County area was again purchased by the United States, this time from the Indians who claimed eastern Iowa as their tribal home. The first purchase in 1832 included the eastern part of present Linn County, and the purchase in 1837 included the balance of Linn County. In 1837 William Abbe built a pole cabin near Mount Vernon on the banks of a creek and became the first new settler in Linn County. He, and later Robert Ellis, sold supplies to army posts west of the Mississippi River. Other early settlers were William Earl, Asa Farnsworth, Daniel Hahn, and Judge George Greeve. The county was named in honor of Lewis Field Linn, who served as Senator from Missouri from 1833 to 1843.

In 1839 three county commissioners were elected, which established Linn County as a government unit. They chose a site, surveyed it, and called it Marion in honor of the Revolutionary War General Francis Marion. A court house was built by 1843 and remained the county seat until a county-wide vote transferred the seat of government to Cedar Rapids in 1919. The present courthouse was built on May's Island in 1924.

The first railroad to reach Linn County was in 1858, when the railroad was extended as far west as Lisbon. The railroad was extended to Cedar Rapids in 1865.

By 1860 Cedar Rapids had a population of more than 3,000. Linn County has enjoyed a steady increase in its population during the past 60 years. This population increase has, for the most part, been in and around the incorporated towns and cities of the county. In 1970 the population of Linn County exceeded 150,000.

Climate[1]

The climate of Linn County is typically continental. It is characterized by frequent and often rapid changes in weather throughout the year. Summers are warm and winters are cold, but prolonged periods of extreme heat or intense cold are comparatively rare. Two major storm tracts, one from the northeast and the other from the southwest, account for most of the pronounced and sometimes violent changes in weather. The climatic data for Cedar Rapids are generally applicable to Linn County, and these data are given in tables 8 and 9.

Approximately 75 percent of the annual precipitation, averaging 33.4 inches, falls during the period from April through September. A trace or more of precipitation falls on about 175 days per year. Of this, 0.01 inch or more falls on more than 100 days, at least 0.10 inch falls on 60 days, and 0.50 inch or more falls on 20 days. Most of the heavy showers are in spring and in summer during periods of maximum tillage, thereby creating the potential for maximum erosion. A 4-inch rainfall during a 24-hour period can be expected once in 4 years, and a 6.5 inch rainfall once in 100 years. Showers exhibit considerable variability within short distances.

The average annual snowfall in Linn County is about 30 inches, or one-tenth of the annual precipitation. There is usually a snow cover of an inch or more on 64 days per year. The snowfall season usually begins early in November, and the first 1-inch snowfall is around the end of November. Snowfalls of 1 inch usually occur no later than about April 1.

During the crop-planting season, soils ideally have little moisture in the topsoil, but abundant moisture in the subsoil. Variations from the optimum are relatively frequent. Normally, May and June are the wettest months of the year. July and August are generally drier. Sometimes they are too dry for growing corn, which requires about an inch of moisture per week for optimum growth. The kind of drought reported in the 1930's and mid-1950's is rare, but some drought is likely late in July or August, when the probability of an inch of rainfall in a week is about one in five.

Temperatures have been as low as −36° F. in January 1883 to as high as 110° on July 5, 1911. The average hottest day in summer is 97°. On the average, 22 days per summer have a maximum temperature equal to or greater than 90°, which is more than is desirable for optimum growth and development of corn. Minimum temperatures tend to be lower on calm, clear nights in the rural lowlands.

[1] By PAUL J. WAITE, climatologist for Iowa, National Weather Service, U.S. Department of Commerce.

TABLE 8.—*Temperature and precipitation*

[Data from records kept in Cedar Rapids]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average daily highest maximum	Average lowest minimum	Average monthly total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Number days with snow of 1 inch or more	Average depth of snow on days with snow cover
	°F.	°F.	°F.	°F.	Inches	Inches	Inches		Inches
January	30	13	49	−13	1.4	2.8	0.4	21	5
February	34	16	52	−6	1.1	2.2	.3	17	4
March	45	25	69	5	2.3	5.3	.8	10	6
April	61	38	82	24	3.2	5.5	1.2	(1)	2
May	72	49	88	33	3.9	7.1	2.1	0	0
June	81	59	93	44	4.9	8.9	2.3	0	0
July	87	63	95	51	3.7	6.9	1.5	0	0
August	84	61	92	47	3.2	7.3	.9	0	0
September	77	53	89	35	3.7	10.7	1.1	0	0
October	65	42	82	25	2.5	5.6	.2	0	0
November	47	28	69	10	2.1	3.2	.7	2	2
December	34	18	55	−6	1.4	2.6	.6	14	3
Annual	60	39	96	−15	33.4	48.0	25.9	64	4

[1] Less than one-half day.

TABLE 9.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data from Anamosa]

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 5	April 17	May 1	May 9	May 19
2 years in 10 later than	March 30	April 11	April 26	May 4	May 14
5 years in 10 later than	March 20	March 31	April 15	April 24	May 4
Fall:					
1 year in 10 earlier than	October 27	October 17	October 12	September 21	September 12
2 years in 10 earlier than	November 1	October 22	October 18	September 26	September 17
5 years in 10 earlier than	November 12	November 2	October 29	October 7	September 27

Relief and Drainage

Linn County is drained by two large streams that carry drainage water southeastward toward the Mississippi River. The Cedar River, the principal stream, and its tributaries drain the southwestern three-fourths of the county. The northeastern quarter of the county is drained by the Wapsipinicon River and its tributaries.

The relief of the county is characterized by a generally subdued land surface. The greatest relief occurs in areas adjacent to the Cedar and Wapsipinicon Rivers. Typical upland features are the generally flat horizon, low relief, and a gently undulating surface. Relief along the rivers is generally rough and hilly, and in several localities the valley walls are shear cliffs. In some areas, however, the rivers have well-developed flood plains that are several miles wide. The highest altitude, about 1,010 feet, is in the northeastern corner of the county. The lowest altitude, about 690 feet, is in the southeastern corner where the Cedar River crosses the county boundary.

Farming

Although the trend in recent years has been toward a decrease in the number of farms in the county, the size of individual farms generally has increased. Livestock farms far outnumber all other types, and most of the crops harvested are consumed by livestock on the farms where the crops are grown.

The county had a total of 2,145 farms in 1969, according to the State of Iowa Annual Farm Census. In the same year, 400,502 acres was in farms and the average size of the farms was 187 acres. The percentage of land that was operated by the owner was 57.6 percent, and the land that

was operated by tenants was 42.4 percent. The percentage of owner-operated farms in Linn County is higher than the State average, which is 52.5 percent.

Most of the farm income in Linn County is derived from the sale of livestock and livestock products. According to the State of Iowa Annual Farm Census, the various kinds of livestock raised and sold in 1969 were as follows:

Livestock	*Number*
Sows farrowing in fall 1969	13,224
Sows farrowing in spring 1969	14,890
Milk cows 2 years or older	7,784
Beef cows 2 years or older	12,135
Lambs born	6,387
Hogs marketed	194,841
Grain-fed cattle marketed	25,592
Grain-fed sheep and lambs marketed	8,898
Commercial broilers produced	5,830
Hens and pullets of laying age	92,505
Turkeys raised	9,005

Except for soybeans, most field crops grown in Linn County are fed to livestock. Some corn is sold as a cash crop, but the amount varies from year to year and depends largely on the price of feeder cattle, the market for hogs, the cash price for corn, and the quality of the corn crop. Although corn is the principal grain crop, the acreage in soybeans has increased in the last few years. Following is the acreage in various crops in Linn County in 1969:

Crop	*Acres*
Corn for all purposes	135,638
Oats	28,380
Soybeans for beans	51,425
Total all hay	28,537

Transportation, Industries, and Markets

Federal, State, and county highways through the area provide routes for automobile traffic and for the transportation of farm products. U.S. Highway No. 30 crosses the county from east to west, and U.S. Highway No. 218 traverses the southwest corner. U.S. Highway 151 begins at Cedar Rapids and extends east. Scheduled airline flights serve Cedar Rapids, and bus transportation is available for many parts of the county. Railroads or motor freight lines serve every trading center in the county.

Although Linn County is primarily devoted to farming, industry has expanded. Cedar Rapids, the largest industrial center in the county, has a large variety of industries.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Bench terrace. A shelflike embankment of earth that has a level or nearly level top and a steep or nearly vertical downhill face, constructed along the contour of sloping land or across the slope to control runoff and erosion. The downhill face of the bench may be made of rocks or masonry, or it may be planted to vegetation.

Bottom, first. The normal flood plain of a stream; land along the stream subject to overflow.

Bottom, second. An old alluvial plain, generally flat, that borders a stream but is seldom flooded.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the oven-dry weight, after the gravitational, or free, water has been allowed to drain away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Fragipan. A loamy, brittle, subsurface horizon that is very low in organic-matter content and clay but is rich in silt or very fine sand. The layer is seemingly cemented. When dry, it is hard or very hard and has a high bulk density in comparison with the horizon or horizons above it. When moist, the fragipan tends to rupture suddenly if pressure is applied, rather than to deform slowly. The layer is generally mottled, is slowly or very slowly permeable to water, and has few or many bleached fracture planes that form polygons. Fragipans are a few inches to several feet thick; they generally occur below the B horizon, 15 to 40 inches below the surface.

Gleyed soil. A soil in which waterlogging and lack of oxygen have caused the material in one or more horizons to be neutral gray in color. The term "gleyed" is applied to soil horizons with yellow and gray mottling caused by intermittent waterlogging.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that in which the overlying horizons formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Interfluves. The district between adjacent streams flowing in the same direction.

Leaching, soil. The removal of materials in solution by the passage of water through the soil.

Pedisediment. A sediment that covers a pediment rather thinly. A pediment is an erosion surface that lies at the foot of a receded slope, is underlain by rocks or sediment of the upland, is barren or mantled with alluvium, and displays a longitudinal profile, normally concave upward.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Mildly alkaline	7.4 to 7.8
Very strongly acid	4.5 to 5.0	Moderately alkaline	7.9 to 8.4
Strongly acid	5.1 to 5.5	Strongly alkaline	8.5 to 9.0
Medium acid	5.6 to 6.0	Very strongly alkaline	9.1 and higher
Slightly acid	6.1 to 6.5		
Neutral	6.6 to 7.3		

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Site index. A numerical means of expressing the quality of a forest site that is based on the height of the dominant stand at an arbitrarily chosen age; for example, the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stone line. A concentration of coarse rock fragments in soils that generally represents an old weathering surface. In a cross section, the line may be one stone or more thick. The line generally overlies material that weathered in place, and it is ordinarily overlain by sediment of variable thickness.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically, the part of the soil below the solum.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood

plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

Well-graded soil. A soil or soil material consisting of particles that are well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Other information is given in tables as follows:

Acreage and extent, table 1, page 10.
Predicted yields, table 2, page 75.

Engineering uses of the soils, tables 4, 5, and 6, pages 84 through 135.

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group
			Symbol	Page	Number
8B	Judson silty clay loam, 2 to 5 percent slopes-----------	35	IIe-4	70	4
11B	Colo-Ely complex, 2 to 5 percent slopes-----------------	22	IIw-1	70	9
21	Muck, shallow---	43	IIIw-1	72	10
41A	Sparta loamy fine sand, 0 to 2 percent slopes-----------	55	IVs-1	73	2
41B	Sparta loamy fine sand, 2 to 5 percent slopes-----------	56	IVs-1	73	2
41C	Sparta loamy fine sand, 5 to 9 percent slopes-----------	56	IVs-1	73	2
41D	Sparta loamy fine sand, 9 to 18 percent slopes----------	56	VIs-1	74	2
63A	Chelsea loamy fine sand, 0 to 2 percent slopes----------	17	IVs-1	73	2
63B	Chelsea loamy fine sand, 2 to 5 percent slopes----------	18	IVs-1	73	2
63C	Chelsea loamy fine sand, 5 to 9 percent slopes----------	18	IVs-1	73	2
63D	Chelsea loamy fine sand, 9 to 18 percent slopes---------	18	VIs-1	74	2
63F	Chelsea loamy fine sand, 18 to 30 percent slopes--------	18	VIIs-1	74	2
83B	Kenyon loam, 2 to 5 percent slopes----------------------	37	IIe-1	69	6
83C	Kenyon loam, 5 to 9 percent slopes----------------------	37	IIIe-1	71	6
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded---	37	IIIe-1	71	6
83D2	Kenyon loam, 9 to 14 percent slopes, moderately eroded--	37	IIIe-2	71	6
84	Clyde silty clay loam-----------------------------------	20	IIw-1	70	9
88	Nevin silty clay loam-----------------------------------	45	I-2	68	7
110B	Lamont fine sandy loam, 2 to 5 percent slopes-----------	39	IIIe-3	71	3
110C	Lamont fine sandy loam, 5 to 9 percent slopes-----------	39	IIIe-3	71	3
118	Garwin silty clay loam----------------------------------	34	IIw-1	70	9
119A	Muscatine silty clay loam, 1 to 3 percent slopes--------	44	I-2	68	7
T119A	Muscatine silty clay loam, benches, 0 to 2 percent slopes---	44	I-2	68	7
120A	Tama silty clay loam, 0 to 2 percent slopes-------------	58	I-1	68	4
120B	Tama silty clay loam, 2 to 5 percent slopes-------------	58	IIe-1	69	4
120C	Tama silty clay loam, 5 to 9 percent slopes-------------	58	IIIe-1	71	4
120C2	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded---	59	IIIe-1	71	4
T120A	Tama silty clay loam, benches, 0 to 2 percent slopes----	59	I-1	68	4
T120B	Tama silty clay loam, benches, 2 to 5 percent slopes----	59	IIe-1	69	4
133	Colo silty clay loam------------------------------------	21	IIw-1	70	9
133+	Colo silt loam, overwash--------------------------------	21	IIw-1	70	9
151	Marshan silty clay loam, moderately deep----------------	42	IIw-1	70	9
152	Marshan silty clay loam, deep---------------------------	42	IIw-1	70	9
154F	Loamy terrace escarpments, 14 to 30 percent slopes------	41	VIIs-1	74	1
160	Walford silt loam---------------------------------------	61	IIw-2	70	9
T160	Walford silt loam, benches------------------------------	61	IIw-2	70	9
162B	Downs silt loam, 2 to 5 percent slopes------------------	27	IIe-1	69	4
162C	Downs silt loam, 5 to 9 percent slopes------------------	27	IIIe-1	71	4
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded---	27	IIIe-1	71	4
162D	Downs silt loam, 9 to 14 percent slopes-----------------	27	IIIe-2	71	4
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded---	28	IIIe-2	71	4
163B	Fayette silt loam, 2 to 5 percent slopes----------------	29	IIe-1	69	4
163C	Fayette silt loam, 5 to 9 percent slopes----------------	29	IIIe-1	71	4
163C2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded---	29	IIIe-1	71	4
163D	Fayette silt loam, 9 to 14 percent slopes---------------	29	IIIe-2	71	4

Map symbol	Mapping unit	Described on page	Capability unit		Woodland suitability group
			Symbol	Page	Number
163D2	Fayette silt loam, 9 to 14 percent slopes, moderately eroded	29	IIIe-2	71	4
163D3	Fayette silt loam, 9 to 14 percent slopes, severely eroded	30	IVe-1	72	4
163E	Fayette silt loam, 14 to 18 percent slopes	30	IVe-1	72	4
163E2	Fayette silt loam, 14 to 18 percent slopes, moderately eroded	30	IVe-1	72	4
163E3	Fayette silt loam, 14 to 18 percent slopes, severely eroded	30	VIe-1	73	4
163F	Fayette silt loam, 18 to 30 percent slopes	30	VIe-1	73	5
163F2	Fayette silt loam, 18 to 30 percent slopes, moderately eroded	30	VIe-1	73	5
T163B	Fayette silt loam, benches, 2 to 5 percent slopes	30	IIe-1	69	4
165A	Stronghurst silt loam, 0 to 2 percent slopes	58	I-2	68	7
171B	Bassett loam, 2 to 5 percent slopes	13	IIe-1	69	6
171C	Bassett loam, 5 to 9 percent slopes	14	IIIe-1	71	6
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded	14	IIIe-1	71	6
171D2	Bassett loam, 9 to 14 percent slopes, moderately eroded	14	IIIe-2	71	6
171E2	Bassett loam, 14 to 18 percent slopes, moderately eroded	14	IVe-1	72	6
171F2	Bassett loam, 18 to 30 percent slopes, moderately eroded	14	VIe-1	73	6
175A	Dickinson fine sandy loam, 0 to 2 percent slopes	22	IIIs-1	72	3
175B	Dickinson fine sandy loam, 2 to 5 percent slopes	22	IIIe-3	71	3
175C	Dickinson fine sandy loam, 5 to 9 percent slopes	23	IIIe-3	71	3
175D	Dickinson fine sandy loam, 9 to 14 percent slopes	23	IVe-2	73	3
177A	Saude loam, 0 to 2 percent slopes	52	IIs-1	70	3
177B	Saude loam, 2 to 5 percent slopes	52	IIe-2	69	3
177C	Saude loam, 5 to 9 percent slopes	52	IIIe-3	71	3
178A	Waukee loam, 0 to 2 percent slopes	64	I-1	68	3
178B	Waukee loam, 2 to 5 percent slopes	64	IIe-1	69	3
184A	Klinger silty clay loam, 0 to 2 percent slopes	38	I-2	68	7
198B	Floyd loam, 1 to 4 percent slopes	32	IIw-1	70	7
204B	Dodgeville silt loam, deep, 2 to 5 percent slopes	25	IIe-1	69	4
204C	Dodgeville silt loam, deep, 5 to 9 percent slopes	25	IIIe-1	71	4
207C2	Whalan loam, moderately deep, 5 to 9 percent slopes, moderately eroded	66	IIIe-4	71	3
212	Kennebec silt loam	36	I-3	69	8
213B	Rockton loam, deep, 2 to 5 percent slopes	49	IIe-1	69	3
213C	Rockton loam, deep, 5 to 9 percent slopes	50	IIIe-1	71	3
214B	Rockton loam, moderately deep, 2 to 5 percent slopes	50	IIe-2	69	3
214C	Rockton loam, moderately deep, 5 to 9 percent slopes	50	IIIe-4	71	3
214D	Rockton loam, moderately deep, 9 to 14 percent slopes	50	IVe-2	73	3
220A	Nodaway silt loam, 0 to 2 percent slopes	45	I-3	69	8
220B	Nodaway silt loam, 2 to 5 percent slopes	46	IIe-4	70	8
221	Muck, moderately shallow	43	IIIw-1	72	10
225	Lawler loam, moderately deep	40	IIs-2	70	7
226	Lawler loam, deep	40	I-2	68	7
284A	Flagler sandy loam, 0 to 2 percent slopes	31	IIIs-1	72	2
284B	Flagler sandy loam, 2 to 5 percent slopes	31	IIIe-3	71	2
284C	Flagler sandy loam, 5 to 9 percent slopes	31	IIIe-3	71	2
284C2	Flagler sandy loam, 5 to 9 percent slopes, moderately eroded	31	IIIe-3	71	2
285C	Burkhardt sandy loam, 2 to 9 percent slopes	17	IVs-1	73	1

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Woodland suitability group Number
285D2	Burkhardt sandy loam, 9 to 14 percent slopes, moderately eroded	17	VIs-1	74	1
291A	Atterberry silt loam, 0 to 2 percent slopes	12	I-2	68	7
291B	Atterberry silt loam, 2 to 5 percent slopes	12	IIe-3	69	7
T291A	Atterberry silt loam, benches, 0 to 2 percent slopes	12	I-2	68	7
293C	Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes	18	IIIe-3	71	2
293C2	Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes, moderately eroded	18	IIIe-3	71	2
293D	Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes	18	VIe-1	73	2
293D2	Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes, moderately eroded	19	VIe-1	73	2
293F	Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes	19	VIIe-1	74	2
293F2	Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes, moderately eroded	19	VIIe-1	74	2
302C2	Coggon loam, 5 to 9 percent slopes, moderately eroded	21	IIIe-1	71	6
315	Loamy alluvial land	41	Vw-1	73	8
350A	Waukegan silt loam, 0 to 2 percent slopes	65	I-1	68	3
350B	Waukegan silt loam, 2 to 5 percent slopes	65	IIe-1	69	3
350C	Waukegan silt loam, 5 to 9 percent slopes	65	IIIe-1	71	3
351A	Atterberry silt loam, sandy substratum, 0 to 2 percent slopes	13	I-2	68	7
352A	Whittier silt loam, 0 to 2 percent slopes	67	I-1	68	3
352B	Whittier silt loam, 2 to 5 percent slopes	67	IIe-1	69	3
352C2	Whittier silt loam, 5 to 9 percent slopes, moderately eroded	67	IIIe-1	71	3
353B	Tell silt loam, 2 to 5 percent slopes	60	IIe-1	69	3
353C2	Tell silt loam, 5 to 9 percent slopes, moderately eroded	60	IIIe-1	71	3
354	Marsh	41	VIIw-1	74	10
377B	Dinsdale silty clay loam, 2 to 5 percent slopes	24	IIe-1	69	4
377C	Dinsdale silty clay loam, 5 to 9 percent slopes	24	IIIe-1	71	4
377C2	Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded	24	IIIe-1	71	4
381B	Klinger-Maxfield silty clay loams, 2 to 5 percent slopes	38	IIw-1	70	9
382	Maxfield silty clay loam	43	IIw-1	70	9
391B	Clyde-Floyd-Schley complex, 1 to 4 percent slopes	20	IIw-1	70	9
393B	Sparta loamy fine sand, loam substratum, 2 to 5 percent slopes	56	IVs-1	73	2
393C	Sparta loamy fine sand, loam substratum, 5 to 9 percent slopes	56	IVs-1	73	2
398	Tripoli silty clay loam	60	IIw-1	70	9
399A	Readlyn loam, 0 to 2 percent slopes	48	I-2	68	7
407B	Schley loam, 1 to 4 percent slopes	53	IIw-1	70	7
408B	Olin fine sandy loam, 2 to 5 percent slopes	46	IIe-2	69	3
408C	Olin fine sandy loam, 5 to 9 percent slopes	47	IIIe-1	71	3
409B	Dickinson fine sandy loam, loam substratum, 2 to 5 percent slopes	23	IIIe-3	71	3
409C	Dickinson fine sandy loam, loam substratum, 5 to 9 percent slopes	23	IIIe-3	71	3
412C	Sogn loam, 5 to 9 percent slopes	54	IVs-1	73	1
412D	Sogn loam, 9 to 18 percent slopes	55	VIs-1	74	1
412G	Sogn loam, 18 to 30 percent slopes	55	VIIs-1	74	1
426A	Aredale loam, 0 to 2 percent slopes	11	I-1	68	6
426B	Aredale loam, 2 to 5 percent slopes	11	IIe-1	69	6
426C	Aredale loam, 5 to 9 percent slopes	11	IIIe-1	71	6
428B	Ely silt loam, 2 to 5 percent slopes	28	IIe-4	70	7

Map symbol	Mapping unit	Described on page	Capability unit Symbol	Capability unit Page	Woodland suitability group Number
442C	Dickinson-Sparta-Tama complex, 5 to 9 percent slopes---	23	IIIe-3	71	2
442D	Dickinson-Sparta-Tama complex, 9 to 14 percent slopes--	23	IVe-2	73	2
471A	Oran loam, 0 to 2 percent slopes----------------------	47	I-2	68	7
471B	Oran loam, 2 to 5 percent slopes----------------------	47	IIe-3	69	7
478G	Steep rock land---------------------------------------	57	VIIs-1	74	1
484	Lawson silt loam--------------------------------------	41	I-3	69	8
485	Spillville loam---------------------------------------	57	I-3	69	8
578A	Waukee loam, uplands, 0 to 2 percent slopes-----------	64	I-1	68	3
578B	Waukee loam, uplands, 2 to 5 percent slopes-----------	64	IIe-1	69	3
578C	Waukee loam, uplands, 5 to 9 percent slopes-----------	64	IIIe-1	71	3
663D	Seaton silt loam, 9 to 14 percent slopes--------------	53	IIIe-2	71	4
663D2	Seaton silt loam, 9 to 14 percent slopes, moderately eroded---	53	IIIe-2	71	4
663E	Seaton silt loam, 14 to 18 percent slopes-------------	54	IVe-1	72	4
663E2	Seaton silt loam, 14 to 18 percent slopes, moderately eroded---	54	IVe-1	72	4
663F	Seaton silt loam, 18 to 30 percent slopes-------------	54	VIIe-1	74	5
663F2	Seaton silt loam, 18 to 30 percent slopes, moderately eroded---	54	VIIe-1	74	5
725	Hayfield loam, moderately deep------------------------	35	IIs-2	70	7
726	Hayfield loam, deep-----------------------------------	35	I-2	68	7
761A	Franklin silt loam, 0 to 2 percent slopes-------------	33	I-2	68	7
761B	Franklin silt loam, 2 to 5 percent slopes-------------	33	IIe-3	69	7
771B	Waubeek silt loam, 2 to 5 percent slopes--------------	63	IIe-1	69	4
771C2	Waubeek silt loam, 5 to 9 percent slopes, moderately eroded---	63	IIIe-1	71	4
772	Donnan loam, gray subsoil variant---------------------	26	IIIw-2	72	9
777A	Wapsie loam, 0 to 2 percent slopes--------------------	62	IIs-1	70	3
777B	Wapsie loam, 2 to 5 percent slopes--------------------	62	IIe-2	69	3
778A	Sattre loam, 0 to 2 percent slopes--------------------	51	I-1	68	3
778B	Sattre loam, 2 to 5 percent slopes--------------------	51	IIe-1	69	3
778C2	Sattre loam, 5 to 9 percent slopes, moderately eroded--	51	IIIe-1	71	3
782B	Donnan loam, 2 to 5 percent slopes--------------------	26	IIe-3	69	7
782C2	Donnan loam, 5 to 9 percent slopes, moderately eroded--	26	IIIe-1	71	7
793A	Bertrand silt loam, 0 to 2 percent slopes-------------	16	I-1	68	4
793B	Bertrand silt loam, 2 to 5 percent slopes-------------	16	IIe-1	69	4
809B	Bertram sandy loam, 2 to 5 percent slopes-------------	15	IVs-1	73	3
809C	Bertram sandy loam, 5 to 9 percent slopes-------------	15	IVs-1	73	3
977	Richwood silt loam------------------------------------	49	I-1	68	4

SOIL LEGEND

Symbols consist of numbers or a combination of numbers and letters, for example, 88 and 163E. The number designates the kind of soil or land type. A capital letter, T, preceding the number, indicates that the soil occurs on a bench position. A capital letter, A, B, C, D, E, F, or G following a number indicates the slope. Symbols without a slope letter are those of nearly level soils. A final number, 2 or 3, in a symbol shows that the soil is moderately or severely eroded. A "+" at the end of the symbol indicates an overwashed soil.

SYMBOL	NAME
8B	Judson silty clay loam, 2 to 5 percent slopes
11B	Colo-Ely complex, 2 to 5 percent slopes
21	Muck, shallow
41A	Sparta loamy fine sand, 0 to 2 percent slopes
41B	Sparta loamy fine sand, 2 to 5 percent slopes
41C	Sparta loamy fine sand, 5 to 9 percent slopes
41D	Sparta loamy fine sand, 9 to 18 percent slopes
63A	Chelsea loamy fine sand, 0 to 2 percent slopes
63B	Chelsea loamy fine sand, 2 to 5 percent slopes
63C	Chelsea loamy fine sand, 5 to 9 percent slopes
63D	Chelsea loamy fine sand, 9 to 18 percent slopes
63F	Chelsea loamy fine sand, 18 to 30 percent slopes
83B	Kenyon loam, 2 to 5 percent slopes
83C	Kenyon loam, 5 to 9 percent slopes
83C2	Kenyon loam, 5 to 9 percent slopes, moderately eroded
83D2	Kenyon loam, 9 to 14 percent slopes, moderately eroded
84	Clyde silty clay loam
88	Nevin silty clay loam
110B	Lamont fine sandy loam, 2 to 5 percent slopes
110C	Lamont fine sandy loam, 5 to 9 percent slopes
118	Garwin silty clay loam
119A	Muscatine silty clay loam, 1 to 3 percent slopes
T119A	Muscatine silty clay loam, benches, 0 to 2 percent slopes
120A	Tama silty clay loam, 0 to 2 percent slopes
120B	Tama silty clay loam, 2 to 5 percent slopes
120C	Tama silty clay loam, 5 to 9 percent slopes
120C2	Tama silty clay loam, 5 to 9 percent slopes, moderately eroded
T120A	Tama silty clay loam, benches, 0 to 2 percent slopes
T120B	Tama silty clay loam, benches, 2 to 5 percent slopes
133	Colo silty clay loam
133+	Colo silt loam, overwash
151	Marshan silty clay loam, moderately deep
152	Marshan silty clay loam, deep
154F	Loamy terrace escarpments, 14 to 30 percent slopes
160	Walford silt loam
T160	Walford silt loam, benches
162B	Downs silt loam, 2 to 5 percent slopes
162C	Downs silt loam, 5 to 9 percent slopes
162C2	Downs silt loam, 5 to 9 percent slopes, moderately eroded
162D	Downs silt loam, 9 to 14 percent slopes
162D2	Downs silt loam, 9 to 14 percent slopes, moderately eroded
163B	Fayette silt loam, 2 to 5 percent slopes
163C	Fayette silt loam, 5 to 9 percent slopes
163C2	Fayette silt loam, 5 to 9 percent slopes, moderately eroded
163D	Fayette silt loam, 9 to 14 percent slopes
163D2	Fayette silt loam, 9 to 14 percent slopes, moderately eroded
163D3	Fayette silt loam, 9 to 14 percent slopes, severely eroded
163E	Fayette silt loam, 14 to 18 percent slopes
163E2	Fayette silt loam, 14 to 18 percent slopes, moderately eroded
163E3	Fayette silt loam, 14 to 18 percent slopes, severely eroded
163F	Fayette silt loam, 18 to 30 percent slopes
163F2	Fayette silt loam, 18 to 30 percent slopes, moderately eroded
T163B	Fayette silt loam, benches, 2 to 5 percent slopes
165A	Stronghurst silt loam, 0 to 2 percent slopes
171B	Bassett loam, 2 to 5 percent slopes
171C	Bassett loam, 5 to 9 percent slopes
171C2	Bassett loam, 5 to 9 percent slopes, moderately eroded
171D2	Bassett loam, 9 to 14 percent slopes, moderately eroded
171E2	Bassett loam, 14 to 18 percent slopes, moderately eroded
171F2	Bassett loam, 18 to 30 percent slopes, moderately eroded
175A	Dickinson fine sandy loam, 0 to 2 percent slopes
175B	Dickinson fine sandy loam, 2 to 5 percent slopes
175C	Dickinson fine sandy loam, 5 to 9 percent slopes
175D	Dickinson fine sandy loam, 9 to 14 percent slopes
177A	Saude loam, 0 to 2 percent slopes
177B	Saude loam, 2 to 5 percent slopes
177C	Saude loam, 5 to 9 percent slopes
178A	Waukee loam, 0 to 2 percent slopes
178B	Waukee loam, 2 to 5 percent slopes
184A	Klinger silty clay loam, 0 to 2 percent slopes
198B	Floyd loam, 1 to 4 percent slopes
204B	Dodgeville silt loam, deep, 2 to 5 percent slopes
204C	Dodgeville silt loam, deep, 5 to 9 percent slopes
207C2	Whalan loam, moderately deep, 5 to 9 percent slopes, moderately eroded
212	Kennebec silt loam
213B	Rockton loam, deep, 2 to 5 percent slopes
213C	Rockton loam, deep, 5 to 9 percent slopes
214B	Rockton loam, moderately deep, 2 to 5 percent slopes
214C	Rockton loam, moderately deep, 5 to 9 percent slopes
214D	Rockton loam, moderately deep, 9 to 14 percent slopes
220A	Nodaway silt loam, 0 to 2 percent slopes
220B	Nodaway silt loam, 2 to 5 percent slopes
221	Muck, moderately shallow
225	Lawler loam, moderately deep
226	Lawler loam, deep
284A	Flagler sandy loam, 0 to 2 percent slopes
284B	Flagler sandy loam, 2 to 5 percent slopes
284C	Flagler sandy loam, 5 to 9 percent slopes
284C2	Flagler sandy loam, 5 to 9 percent slopes, moderately eroded
285C	Burkhardt sandy loam, 2 to 9 percent slopes
285D2	Burkhardt sandy loam, 9 to 14 percent slopes, moderately eroded
291A	Atterberry silt loam, 0 to 2 percent slopes
291B	Atterberry silt loam, 2 to 5 percent slopes
T291A	Atterberry silt loam, benches, 0 to 2 percent slopes
293C	Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes
293C2	Chelsea-Lamont-Fayette complex, 5 to 9 percent slopes, moderately eroded
293D	Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes
293D2	Chelsea-Lamont-Fayette complex, 9 to 18 percent slopes, moderately eroded
293F	Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes
293F2	Chelsea-Lamont-Fayette complex, 18 to 30 percent slopes, moderately eroded
302C2	Coggon loam, 5 to 9 percent slopes, moderately eroded
315	Loamy alluvial land
350A	Waukegan silt loam, 0 to 2 percent slopes
350B	Waukegan silt loam, 2 to 5 percent slopes
350C	Waukegan silt loam, 5 to 9 percent slopes
351A	Atterberry silt loam, sandy substratum, 0 to 2 percent slopes
352A	Whittier silt loam, 0 to 2 percent slopes
352B	Whittier silt loam, 2 to 5 percent slopes
352C2	Whittier silt loam, 5 to 9 percent slopes, moderately eroded
353B	Tell silt loam, 2 to 5 percent slopes
353C2	Tell silt loam, 5 to 9 percent slopes, moderately eroded
354	Marsh
377B	Dinsdale silty clay loam, 2 to 5 percent slopes
377C	Dinsdale silty clay loam, 5 to 9 percent slopes
377C2	Dinsdale silty clay loam, 5 to 9 percent slopes, moderately eroded
381B	Klinger-Maxfield silty clay loams, 2 to 5 percent slopes
382	Maxfield silty clay loam
391B	Clyde-Floyd-Schley complex, 1 to 4 percent slopes
393B	Sparta loamy fine sand, loam substratum, 2 to 5 percent slopes
393C	Sparta loamy fine sand, loam substratum, 5 to 9 percent slopes
398	Tripoli silty clay loam
399A	Readlyn loam, 0 to 2 percent slopes
407B	Schley loam, 1 to 4 percent slopes
408B	Olin fine sandy loam, 2 to 5 percent slopes
408C	Olin fine sandy loam, 5 to 9 percent slopes
409B	Dickinson fine sandy loam, loam substratum, 2 to 5 percent slopes
409C	Dickinson fine sandy loam, loam substratum, 5 to 9 percent slopes
412C	Sogn loam, 5 to 9 percent slopes
412D	Sogn loam, 9 to 18 percent slopes
412G	Sogn loam, 18 to 30 percent slopes
426A	Aredale loam, 0 to 2 percent slopes
426B	Aredale loam, 2 to 5 percent slopes
426C	Aredale loam, 5 to 9 percent slopes
428B	Ely silt loam, 2 to 5 percent slopes
442C	Dickinson-Sparta-Tama complex, 5 to 9 percent slopes
442D	Dickinson-Sparta-Tama complex, 9 to 14 percent slopes
471A	Oran loam, 0 to 2 percent slopes
471B	Oran loam, 2 to 5 percent slopes
478G	Steep rock land
484	Lawson silt loam
485	Spillville loam
578A	Waukee loam, uplands, 0 to 2 percent slopes
578B	Waukee loam, uplands, 2 to 5 percent slopes
578C	Waukee loam, uplands, 5 to 9 percent slopes
663D	Seaton silt loam, 9 to 14 percent slopes
663D2	Seaton silt loam, 9 to 14 percent slopes, moderately eroded
663E	Seaton silt loam, 14 to 18 percent slopes
663E2	Seaton silt loam, 14 to 18 percent slopes, moderately eroded
663F	Seaton silt loam, 18 to 30 percent slopes
663F2	Seaton silt loam, 18 to 30 percent slopes, moderately eroded
725	Hayfield loam, moderately deep
726	Hayfield loam, deep
761A	Franklin silt loam, 0 to 2 percent slopes
761B	Franklin silt loam, 2 to 5 percent slopes
771B	Waubeek silt loam, 2 to 5 percent slopes
771C2	Waubeek silt loam, 5 to 9 percent slopes, moderately eroded
772	Donnan loam, gray subsoil variant
777A	Wapsie loam, 0 to 2 percent slopes
777B	Wapsie loam, 2 to 5 percent slopes
778A	Sattre loam, 0 to 2 percent slopes
778B	Sattre loam, 2 to 5 percent slopes
778C2	Sattre loam, 5 to 9 percent slopes, moderately eroded
782B	Donnan loam, 2 to 5 percent slopes
782C2	Donnan loam, 5 to 9 percent slopes, moderately eroded
793A	Bertrand silt loam, 0 to 2 percent slopes
793B	Bertrand silt loam, 2 to 5 percent slopes
809B	Bertram sandy loam, 2 to 5 percent slopes
809C	Bertram sandy loam, 5 to 9 percent slopes
977	Richwood silt loam

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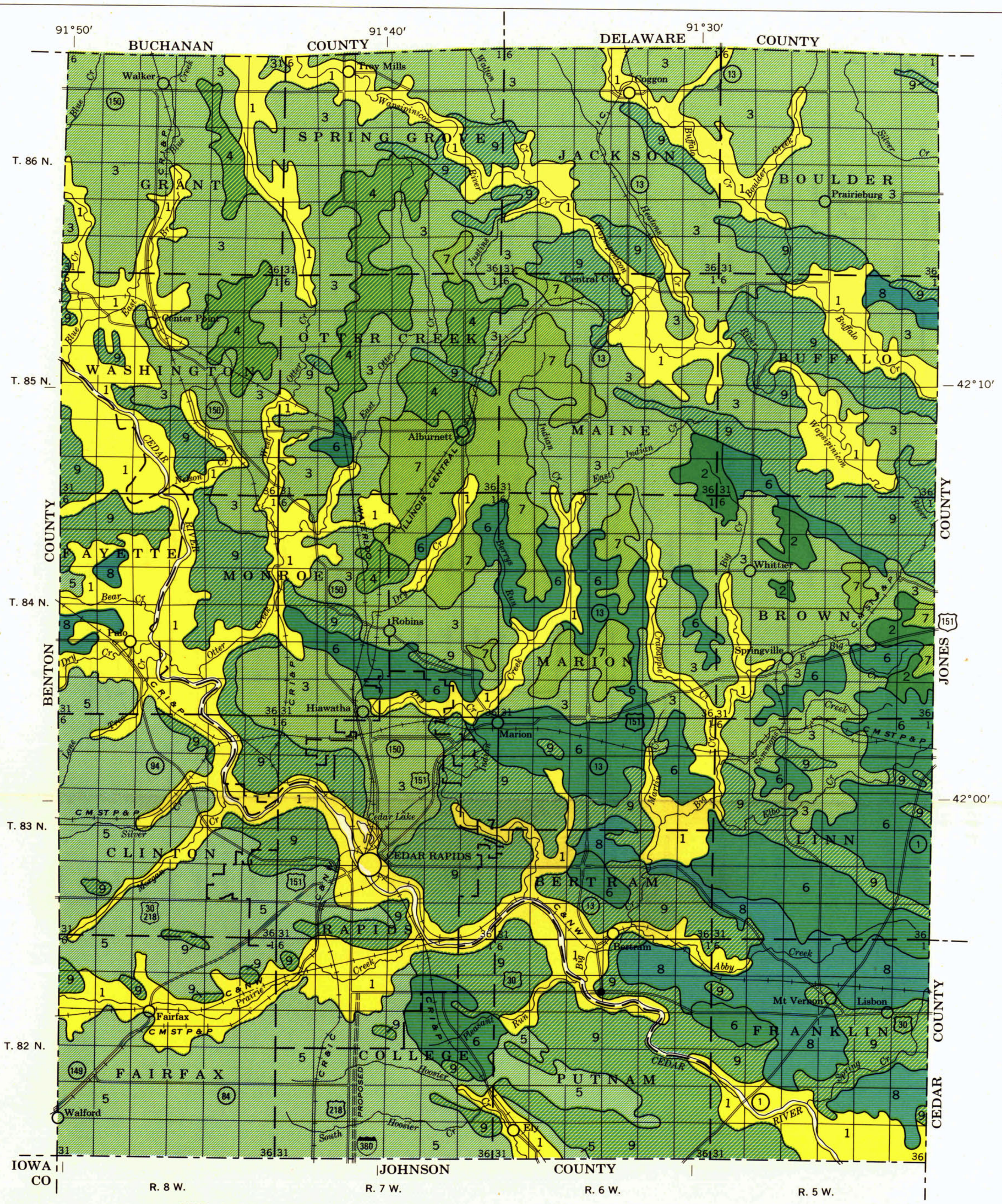


SOIL ASSOCIATIONS

1 — Loamy alluvial land-Sparta-Spillville association: Nearly level to moderately sloping, dark-colored to light-colored, excessively drained to poorly drained soils formed in sandy and loamy material; on bottom lands and stream benches

2 — Waukee-Dickinson association: Nearly level to moderately sloping, well-drained and somewhat excessively drained, dark-colored soils formed in loamy material underlain by sand; on uplands

3 — Kenyon-Clyde-Floyd association: Nearly level to strongly sloping, dark-colored, moderately well drained to poorly drained soils formed in loamy material and glacial till; on uplands

4 — Readlyn-Oran-Tripoli association: Nearly level, dark colored to moderately dark colored, somewhat poorly drained and poorly drained soils formed in loamy material and glacial till; on uplands

5 — Kenyon-Dinsdale association: Gently sloping to strongly sloping, dark-colored, well drained and moderately well drained soils formed in loamy material and glacial till or in silty material and glacial till; on uplands

6 — Dinsdale-Klinger association: Nearly level to moderately sloping, dark-colored, well-drained to somewhat poorly drained soils formed in silty material and glacial till; on uplands

7 — Klinger-Franklin-Maxfield association: Nearly level, dark colored to moderately dark colored, somewhat poorly drained and poorly drained soils formed in silty material and glacial till; on uplands

8 — Tama-Colo-Ely association: Nearly level to moderately sloping, dark-colored, well-drained, somewhat poorly drained, and poorly drained soils formed in silty material; on uplands and in upland drainageways

9 — Fayette-Downs-Chelsea association: Gently sloping to very steep, light-colored to moderately dark colored, well-drained and excessively drained soils formed in silty and sandy material; on uplands

Compiled 1973

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION
COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY
DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

GENERAL SOIL MAP

LINN COUNTY, IOWA

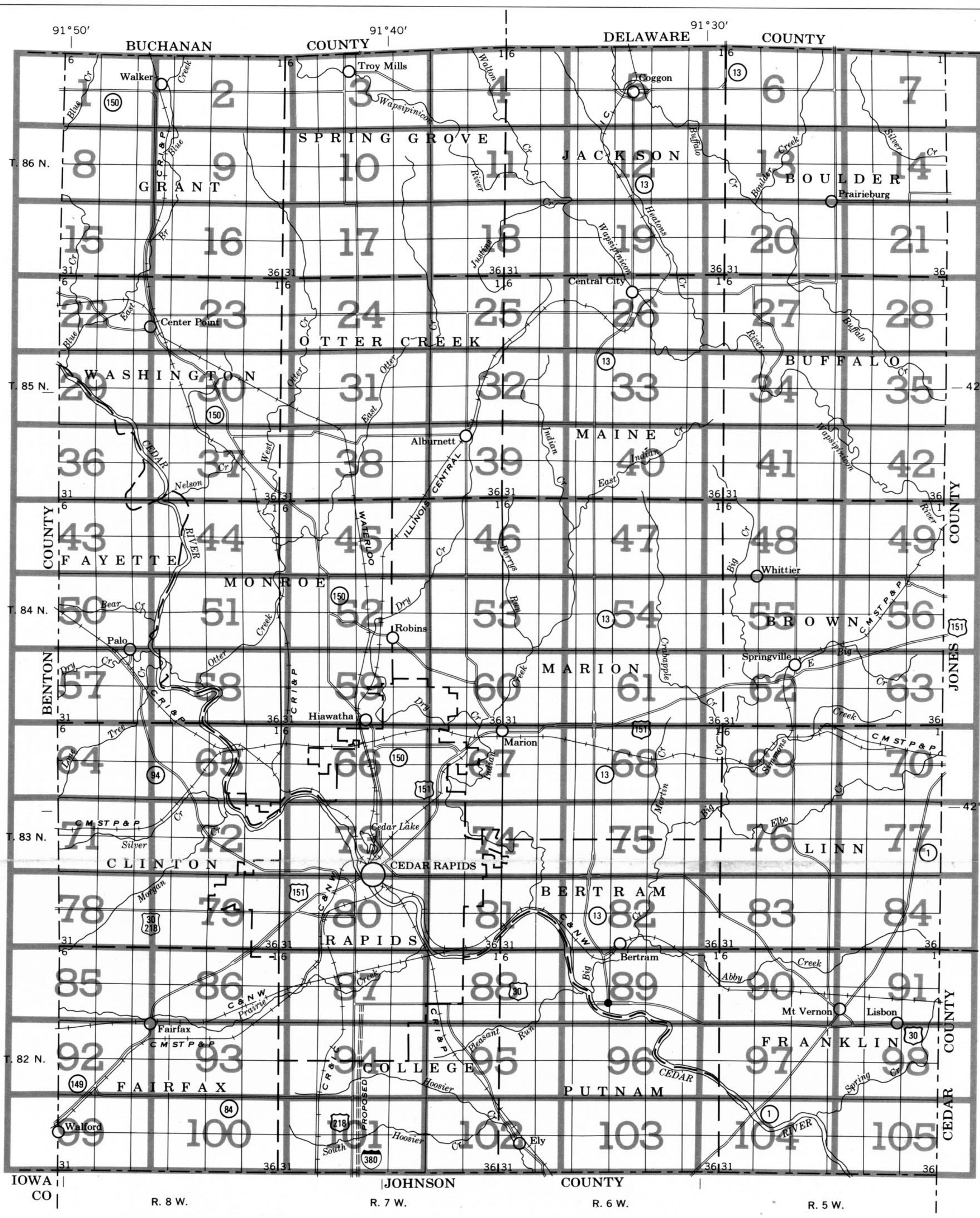
Scale 1:190,080

1 0 1 2 3 4 Miles

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



INDEX TO MAP SHEETS

LINN COUNTY, IOWA

Scale 1:190,080

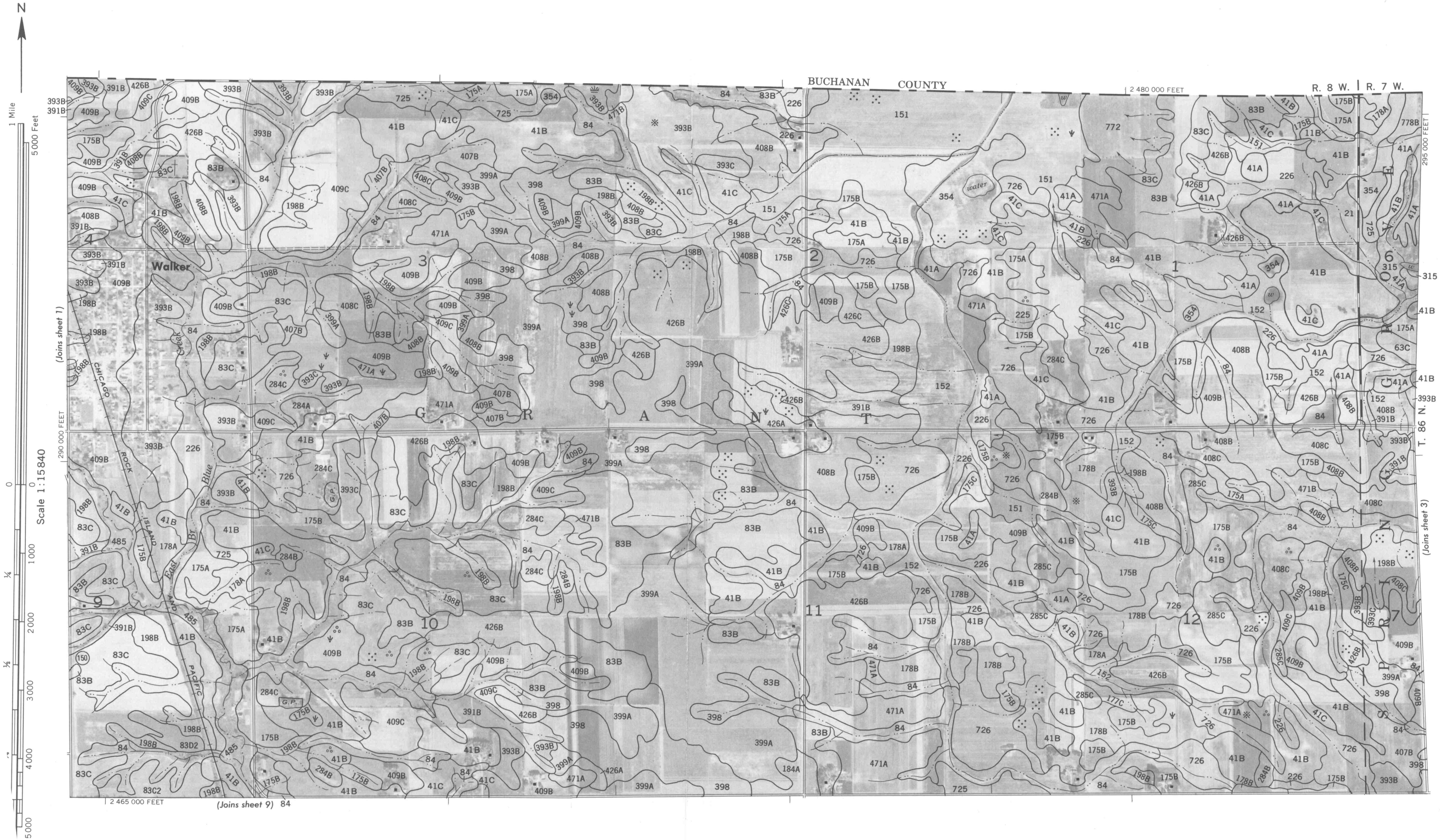
1 0 1 2 3 4 Miles

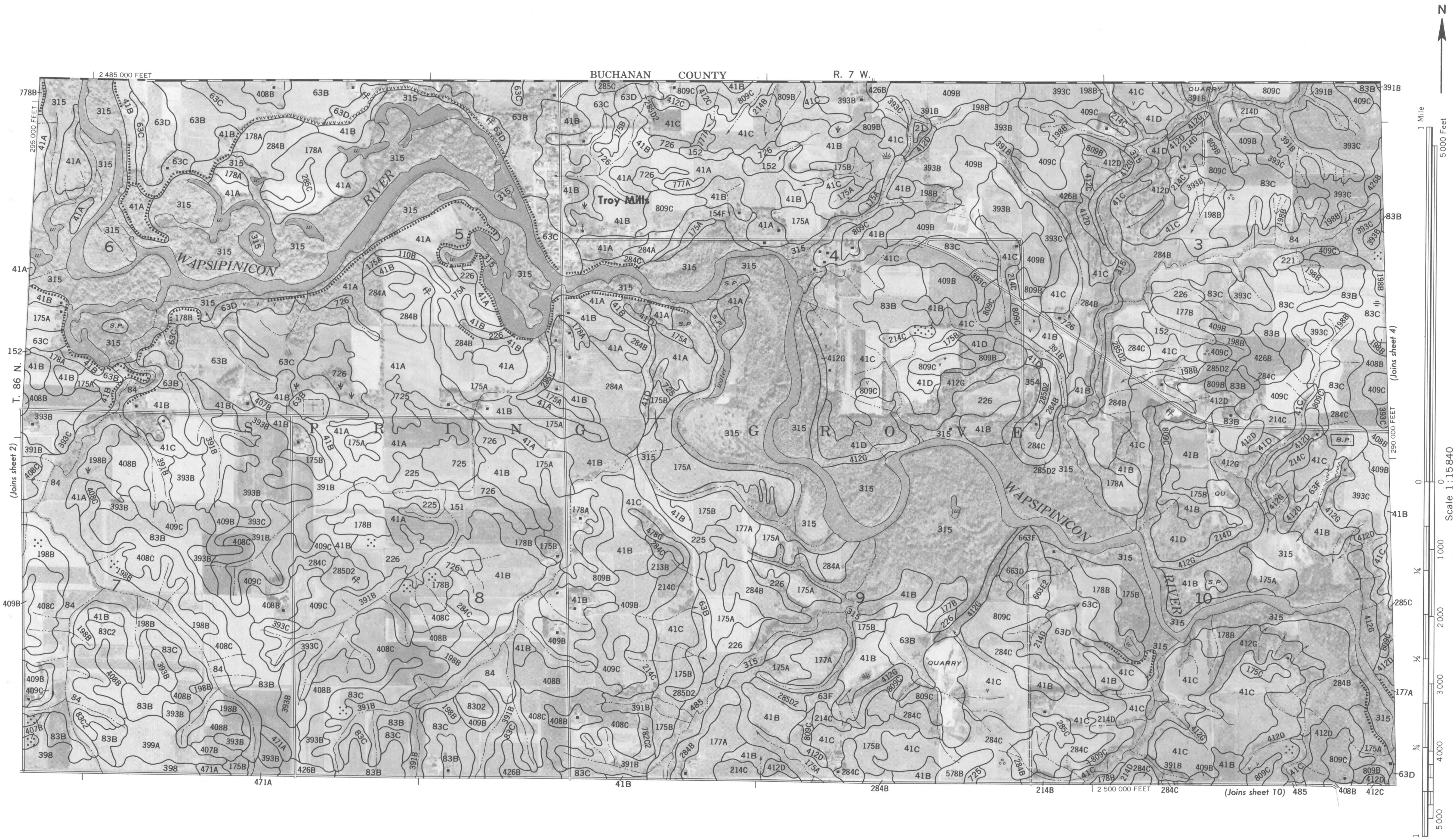
SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

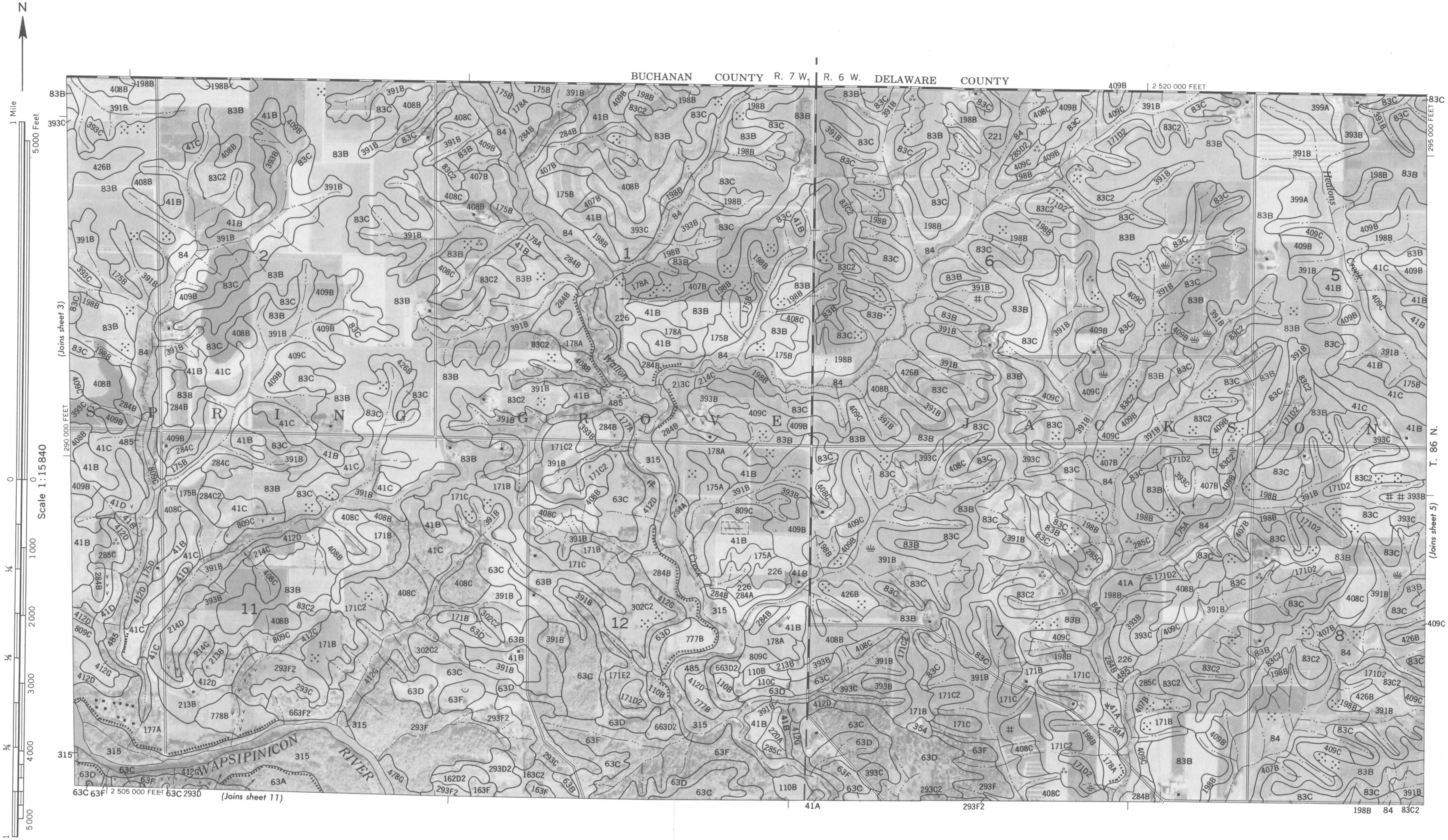
1

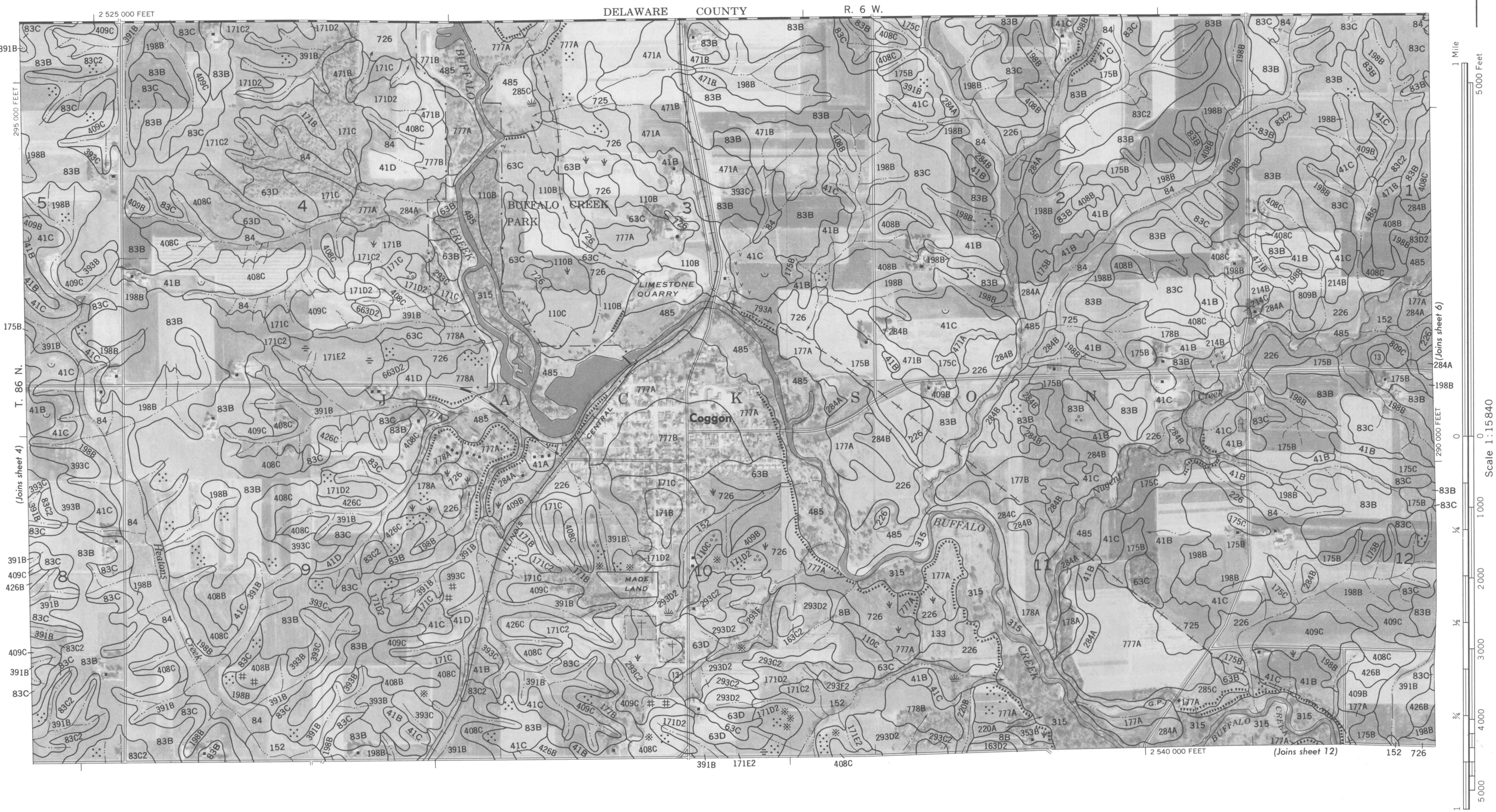

N
BUCHANAN COUNTY
R. 8 W.
T. 86 N.
BENTON COUNTY
G R A N T
Walker
Blue Creek
BORROW PIT
2 445 000 FEET
2 460 000 FEET
295 000 FEET
290 000 FEET
(Joins sheet 2)
(Joins sheet 8)
Scale 1:15840
1 Mile
5000 Feet

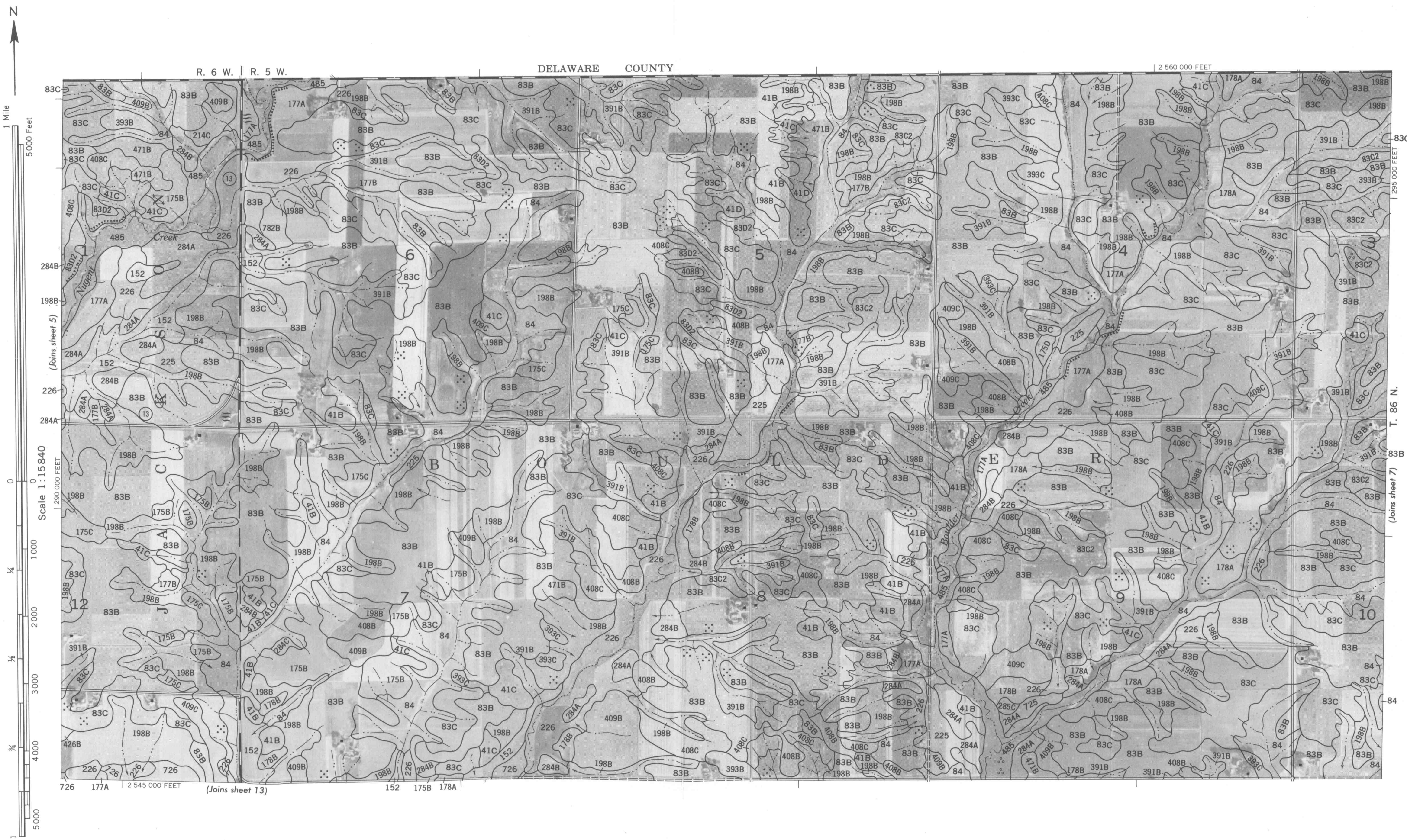

N
1 Mile
5 000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
BUCHANAN COUNTY
R. 8 W.
R. 7 W.
T. 86 N.
2 480 000 FEET
2 465 000 FEET
290 000 FEET
295 000 FEET
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 9)
Walker
GRANT
CHICAGO ROCK ISLAND AND PACIFIC
East Blue Creek
CEDAR RIVER
water
G.P.


3
N
BUCHANAN COUNTY
R. 7 W.
2 485 000 FEET
2 500 000 FEET
295 000 FEET
290 000 FEET
T. 86 N.
Troy Mills
WAPSIPINICON RIVER
S P R I N G G R O V E
QUARRY
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 10)
1 Mile
5000 Feet
Scale 1:15 840
LINN COUNTY, IOWA NO. 3

LINN COUNTY, IOWA — SHEET NUMBER 4




N
DELAWARE COUNTY
R. 6 W.
T. 86 N.
2 525 000 FEET
295 000 FEET
290 000 FEET
2 540 000 FEET
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 12)
BUFFALO CREEK PARK
LIMESTONE QUARRY
Coggon
J A C K S O N
BUFFALO CREEK
Heatons Creek
Nugent Creek
MADE LAND
1 Mile
5000 Feet
Scale 1:15 840



Land division corners are approximately positioned on this map.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.
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LINN COUNTY, IOWA NO. 7

LINN COUNTY, IOWA — SHEET NUMBER 8

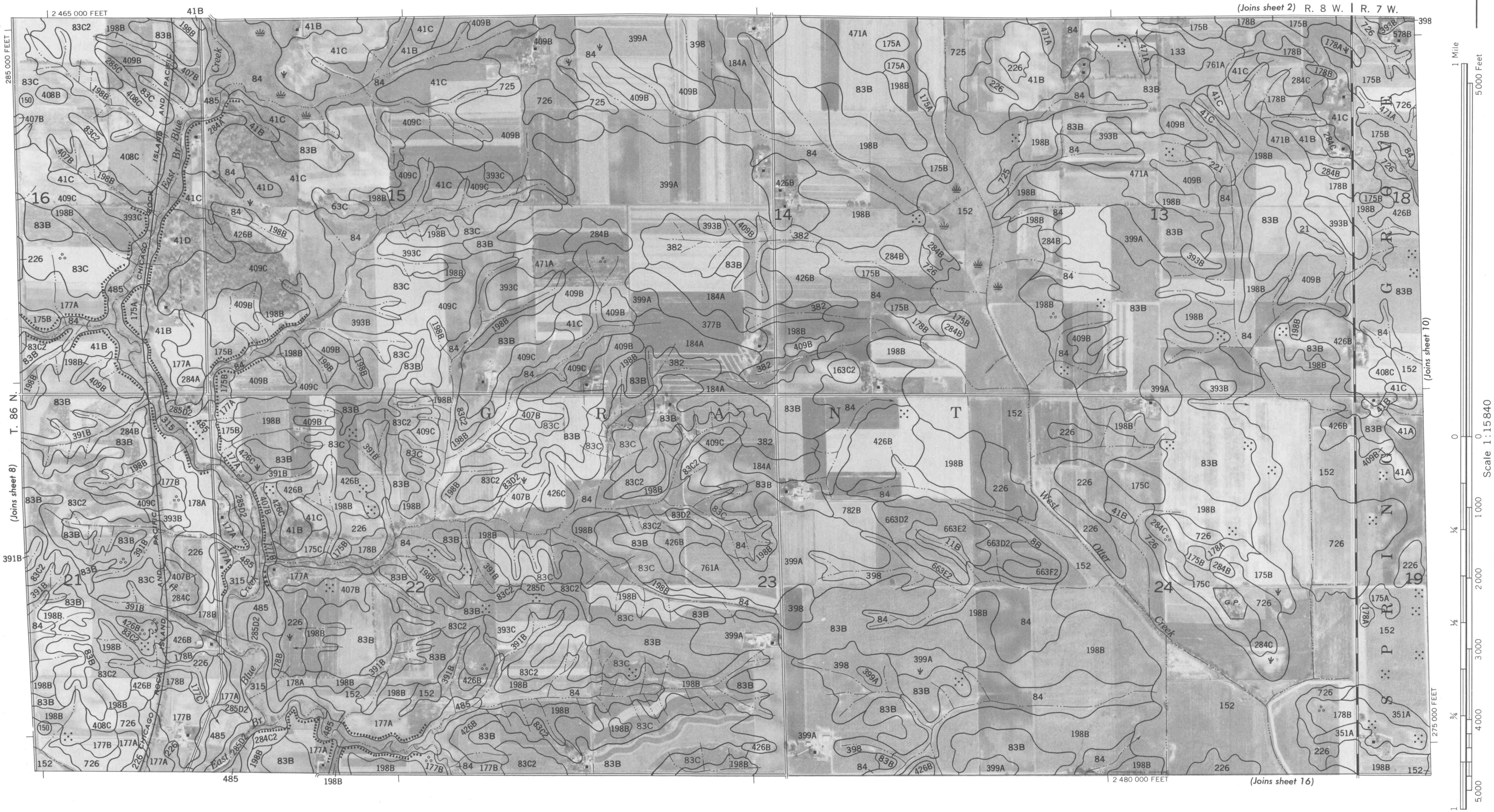
N

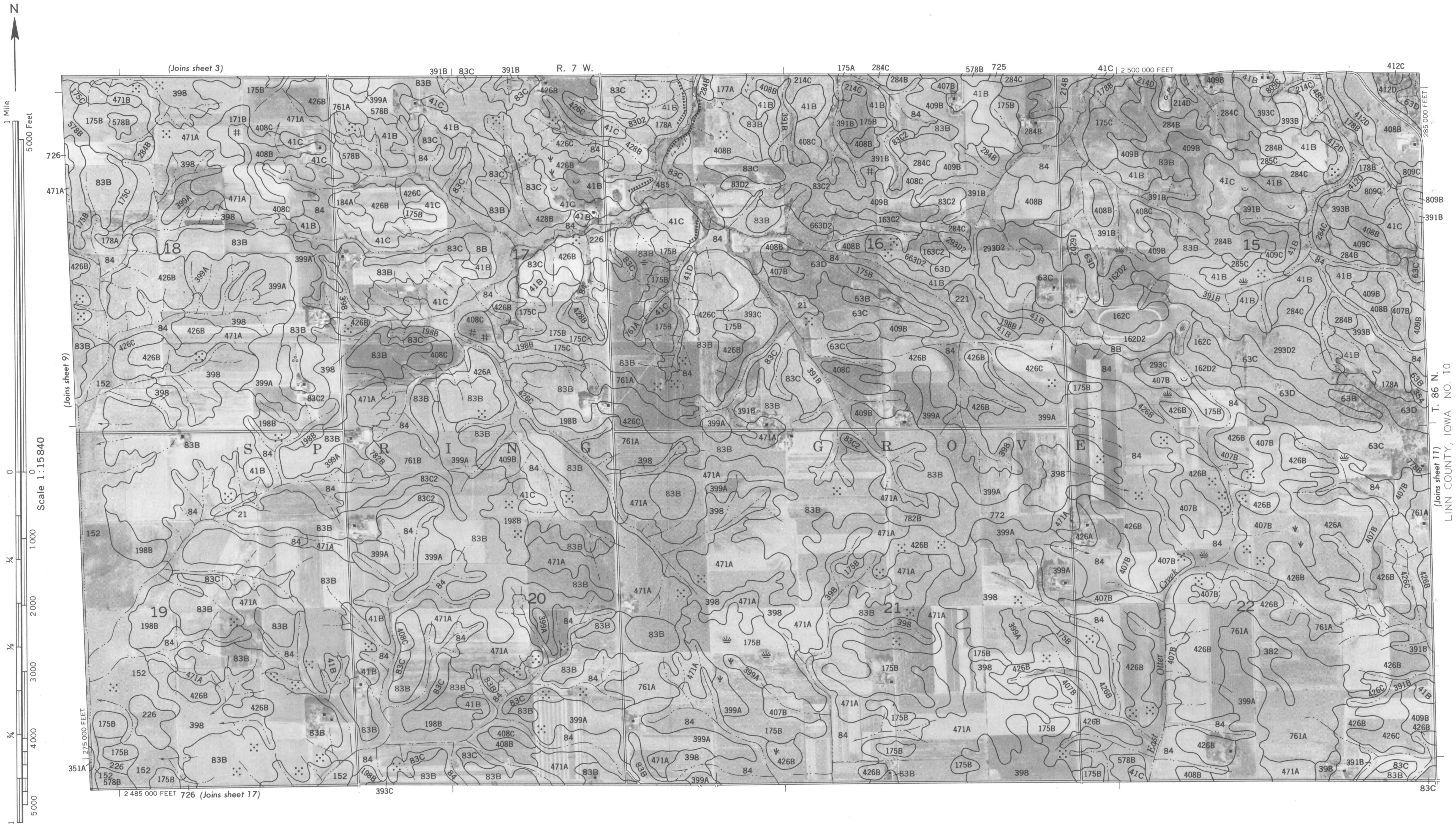
1 Mile

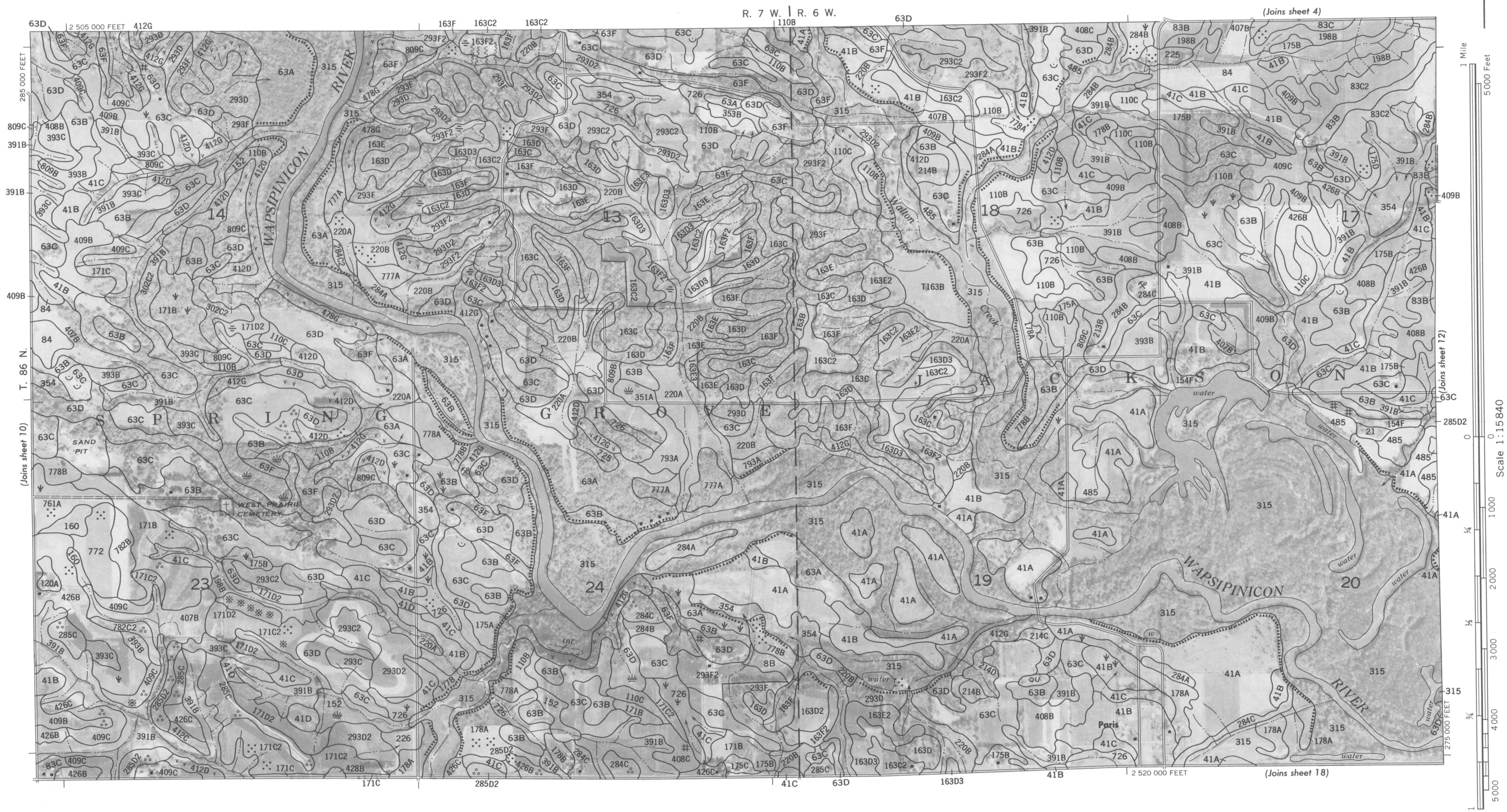
5000 Feet

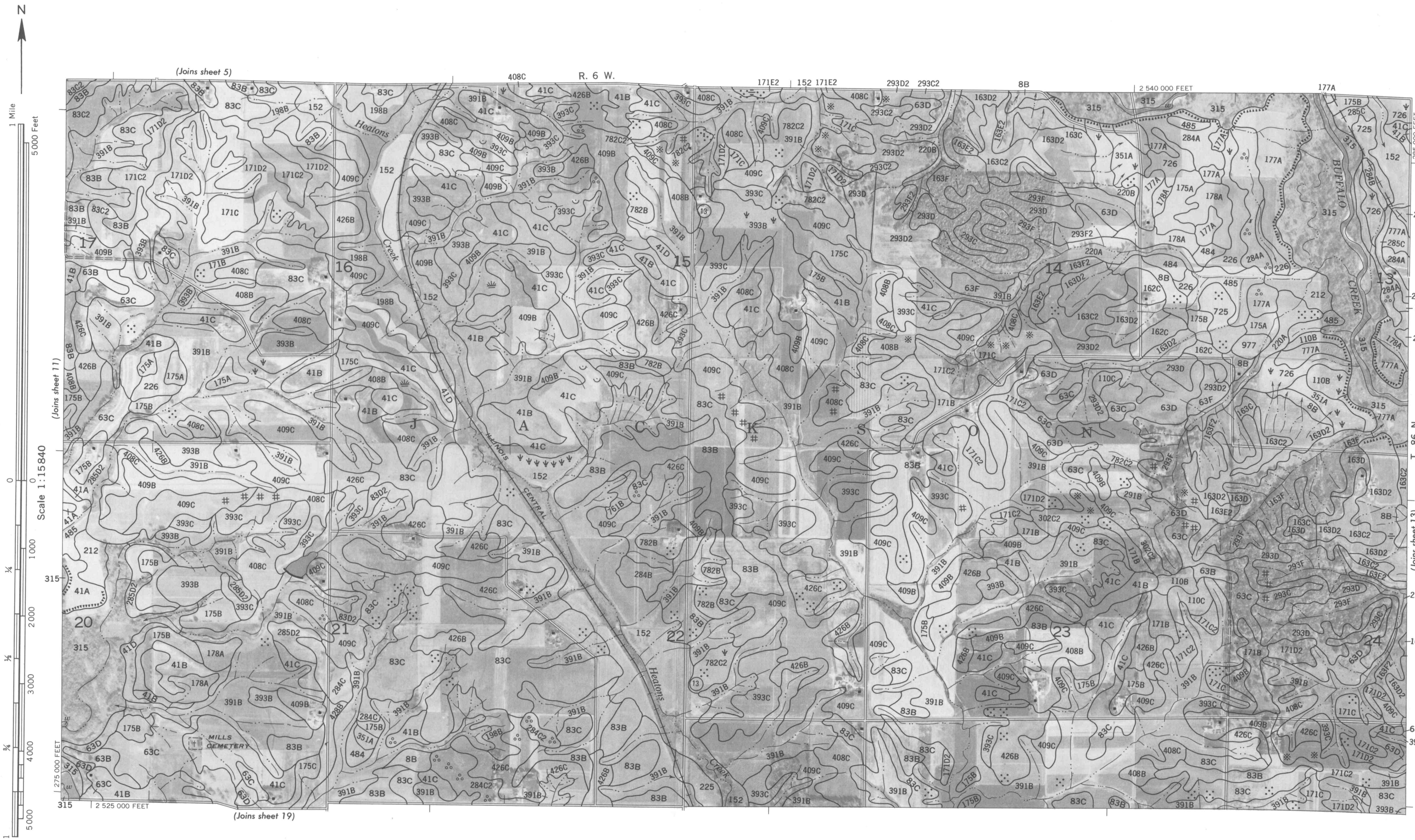
Scale 1:15840

0 1000 2000 3000 4000 5000

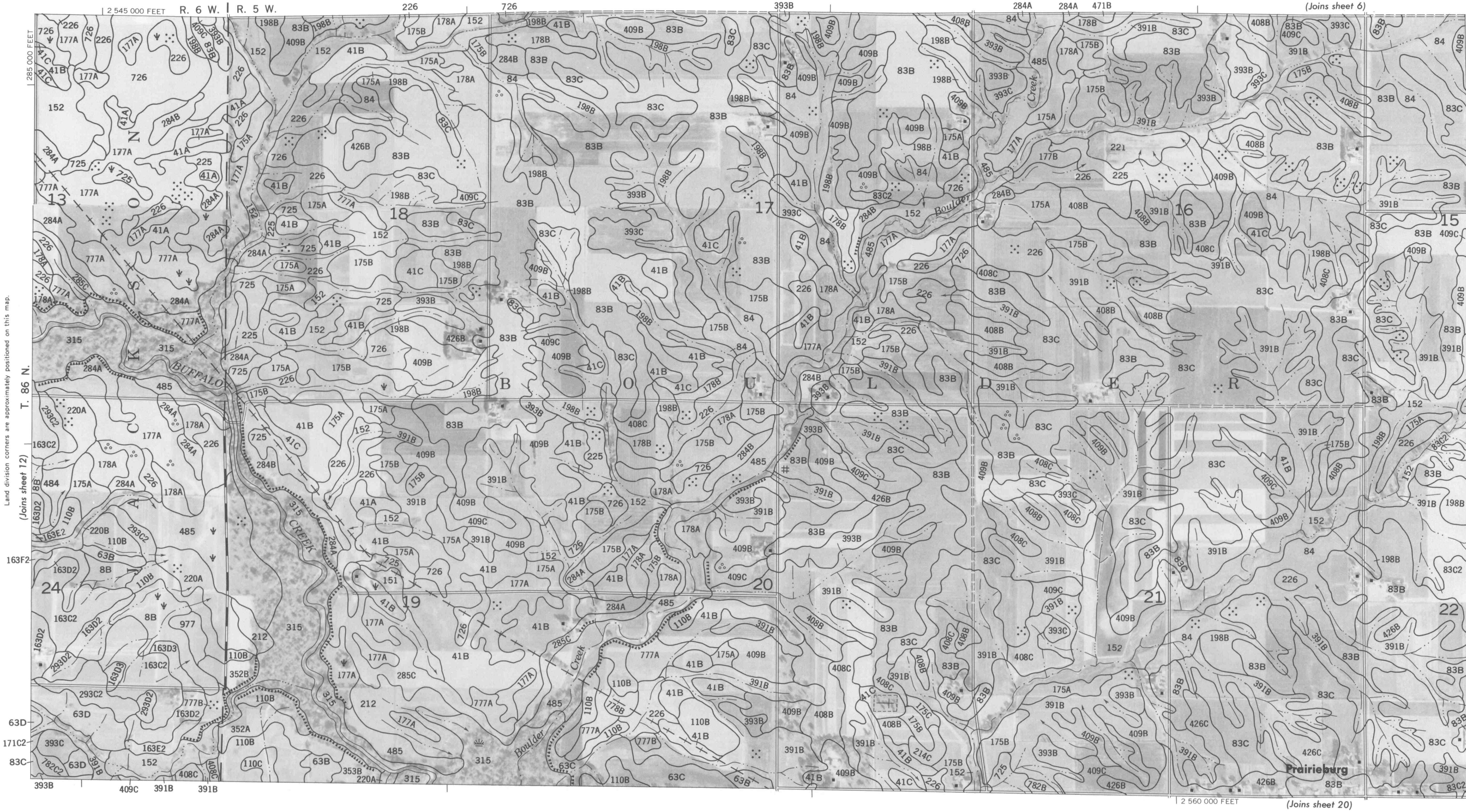

N
(Joins sheet 2)
R. 8 W.
R. 7 W.
2 465 000 FEET
285 000 FEET
T. 86 N.
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 16)
2 480 000 FEET
275 000 FEET
GRANT
SPRING GROVE
East Br. Blue Creek
West Otter Creek
CHICAGO ROCK ISLAND AND PACIFIC
16
15
14
13
18
21
22
23
24
19
Scale 1:15 840
1 Mile
5000 Feet


N
Scale 1:15840
1 Mile
5 000 Feet
(Joins sheet 3)
R. 7 W.
2 500 000 FEET
285 000 FEET
(Joins sheet 9)
(Joins sheet 11)
T. 86 N.
275 000 FEET
2 485 000 FEET
(Joins sheet 17)
S P R I N G G R O V E
18
17
16
15
19
20
21
22
Otter
East
Creek
LINN COUNTY, IOWA NO. 10

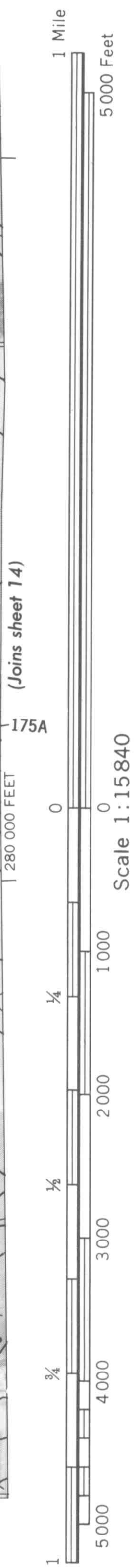

N
R. 7 W.
R. 6 W.
T. 86 N.
2 505 000 FEET
2 520 000 FEET
285 000 FEET
275 000 FEET
(Joins sheet 4)
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 18)
WAPSIPINICON RIVER
WAPSIPINICON RIVER
Walton Creek
SPRING GROVE
JACKSON
SAND PIT
WEST PRAIRIE CEMETERY
Paris
water
14
13
18
17
23
24
19
20
1 Mile
5000 Feet
Scale 1:15840

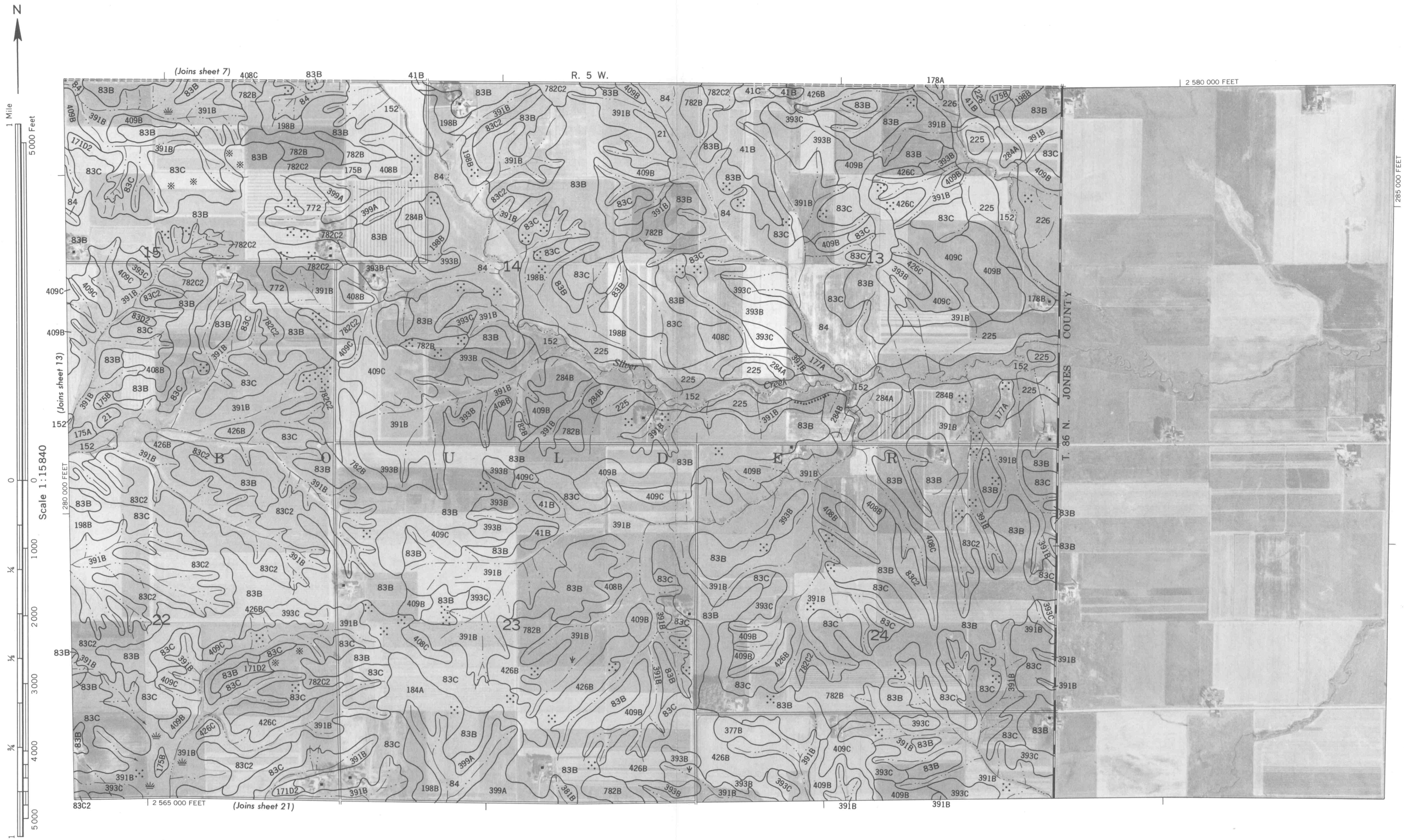

N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 5)
R. 6 W.
2 540 000 FEET
285 000 FEET
(Joins sheet 11)
(Joins sheet 13)
T. 86 N.
(Joins sheet 19)
275 000 FEET
2 525 000 FEET
Heatons Creek
BUFFALO CREEK
ILLINOIS CENTRAL
JACKSON
MILLS CEMETERY

13


2 545 000 FEET
R. 6 W.
R. 5 W.
285 000 FEET
280 000 FEET
2 560 000 FEET
T. 86 N.
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 20)
13
14
15
16
17
18
19
20
21
22
24
BUFFALO
CREEK
Boulder
Creek
Prairieburg
K N O X
J A C K S O N
B O U L D E R

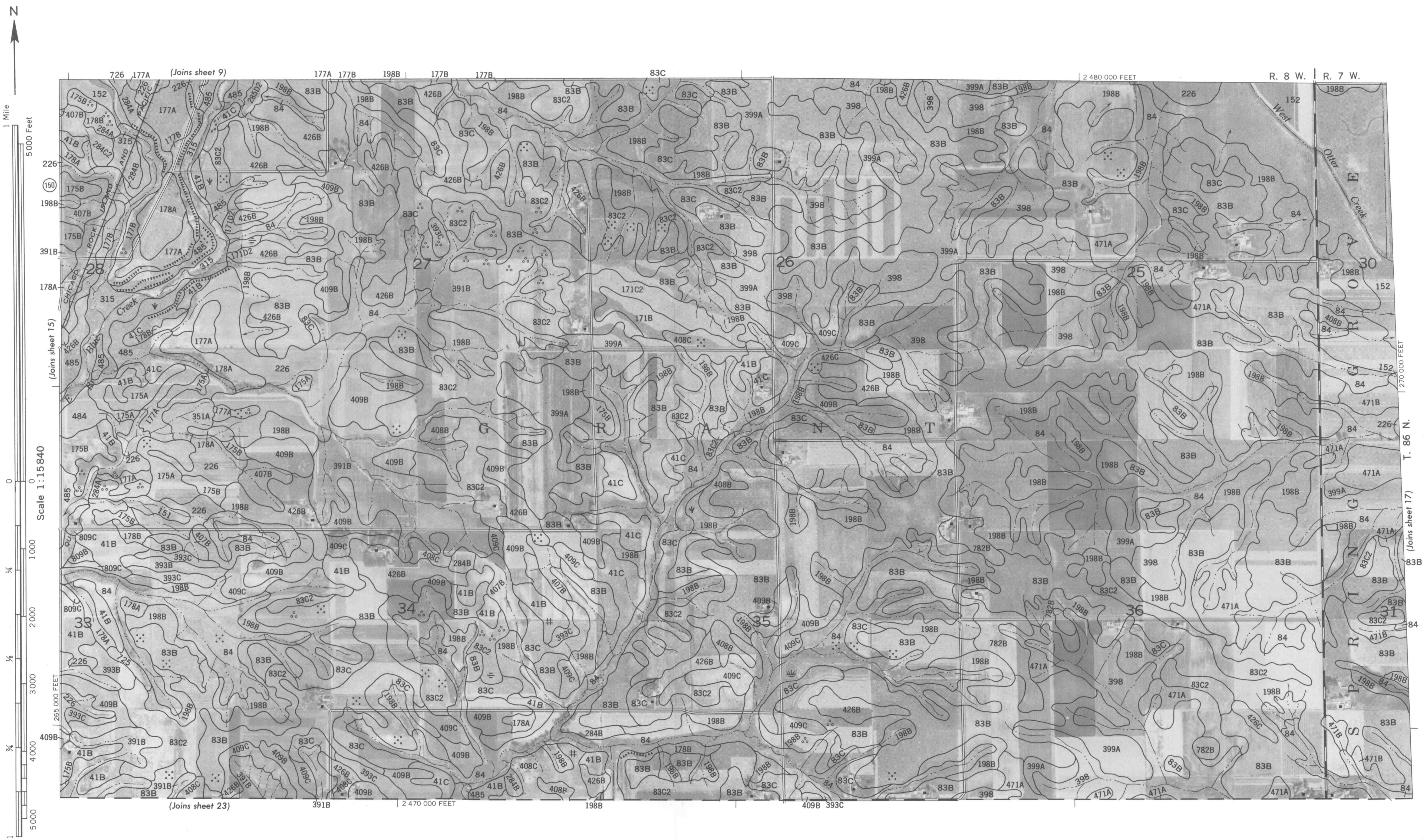
N

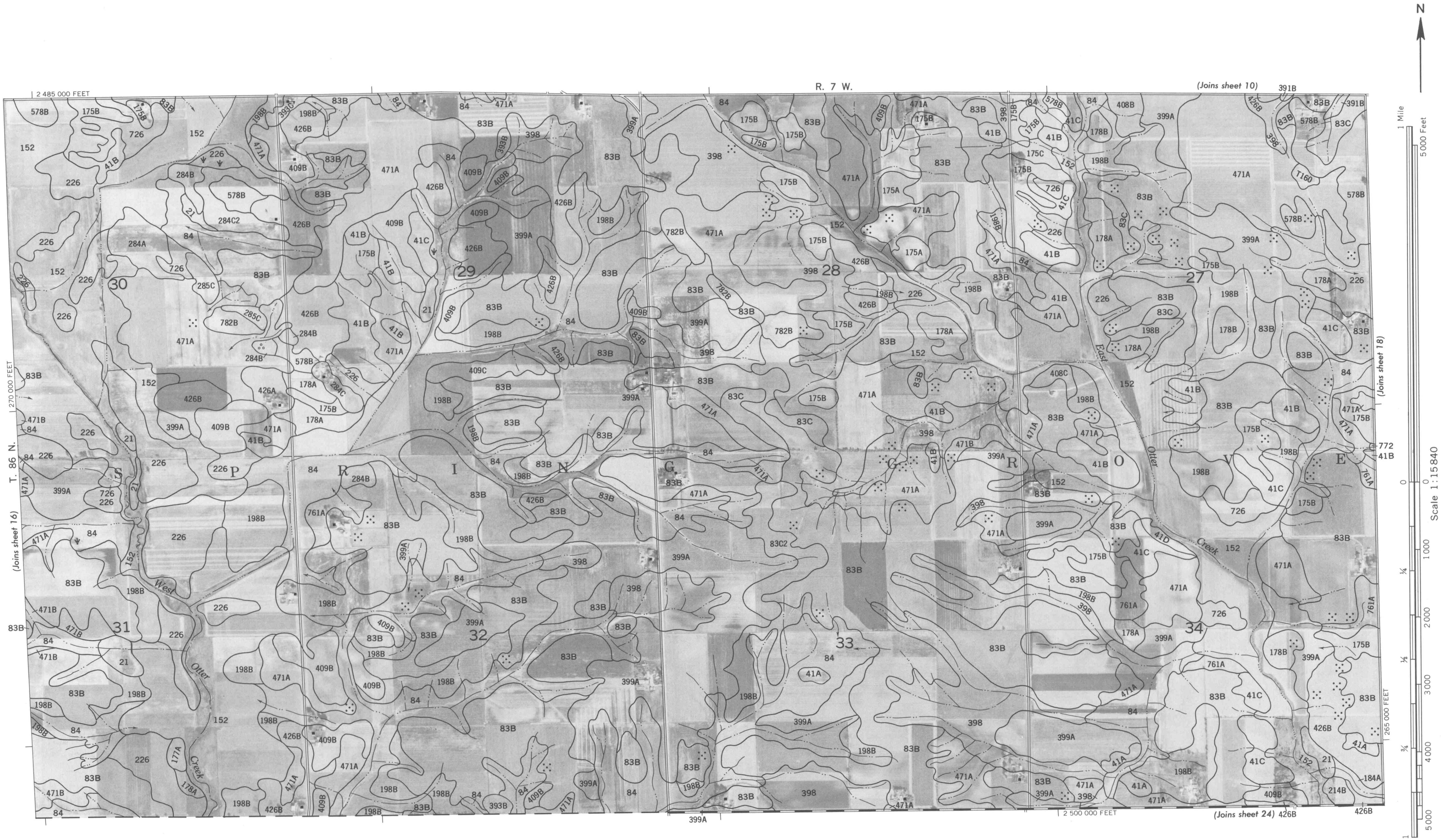

1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
0
¼
½
¾
1
Scale 1:15 840


N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 7)
R. 5 W.
2 580 000 FEET
285 000 FEET
280 000 FEET
(Joins sheet 13)
JONES COUNTY
T. 86 N.
Silver Creek
B O U L D E R
15
14
13
22
23
24
2 565 000 FEET
(Joins sheet 21)

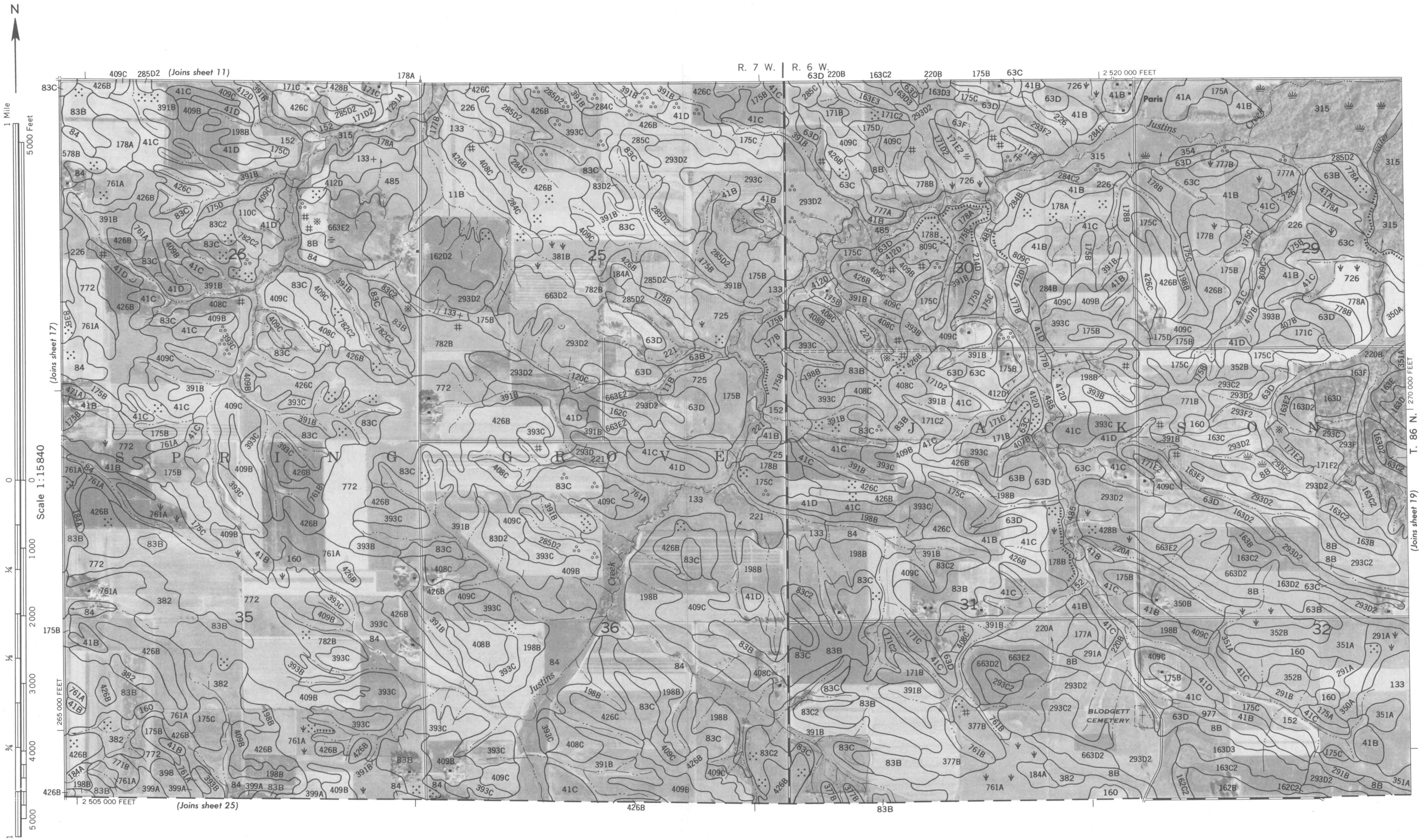
15


N
R. 8 W.
T. 86 N.
2 450 000 FEET
2 465 000 FEET
270 000 FEET
265 000 FEET
(Joins sheet 8)
(Joins sheet 16)
(Joins sheet 22)
BENTON COUNTY
DAVIS CEMETERY
BLUE CREEK
CHICAGO ROCK ISLAND AND PACIFIC
East Blue Cr
G R A N T
28
29
30
31
32
33
Scale 1:15 840
1 Mile
5 000 Feet


N
1 Mile
5 000 Feet
Scale 1:15840
(Joins sheet 9)
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 23)
R. 8 W.
R. 7 W.
T. 86 N.
2 480 000 FEET
2 470 000 FEET
270 000 FEET
265 000 FEET
GRANT
SPRING GROVE
CHICAGO ROCK ISLAND AND PACIFIC
Blue Creek
West Otter Creek
150
25
26
27
28
30
31
33
34
35
36

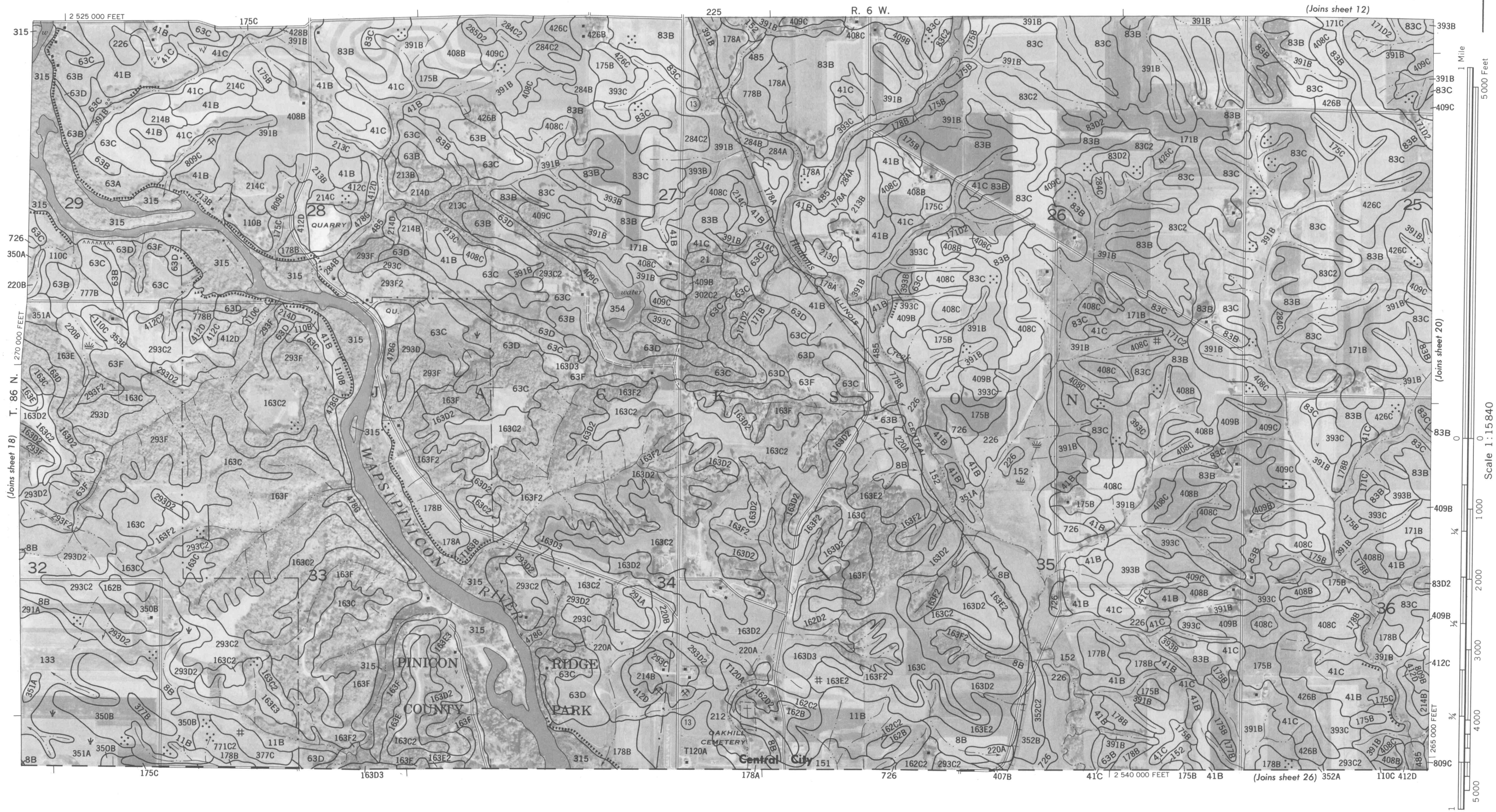


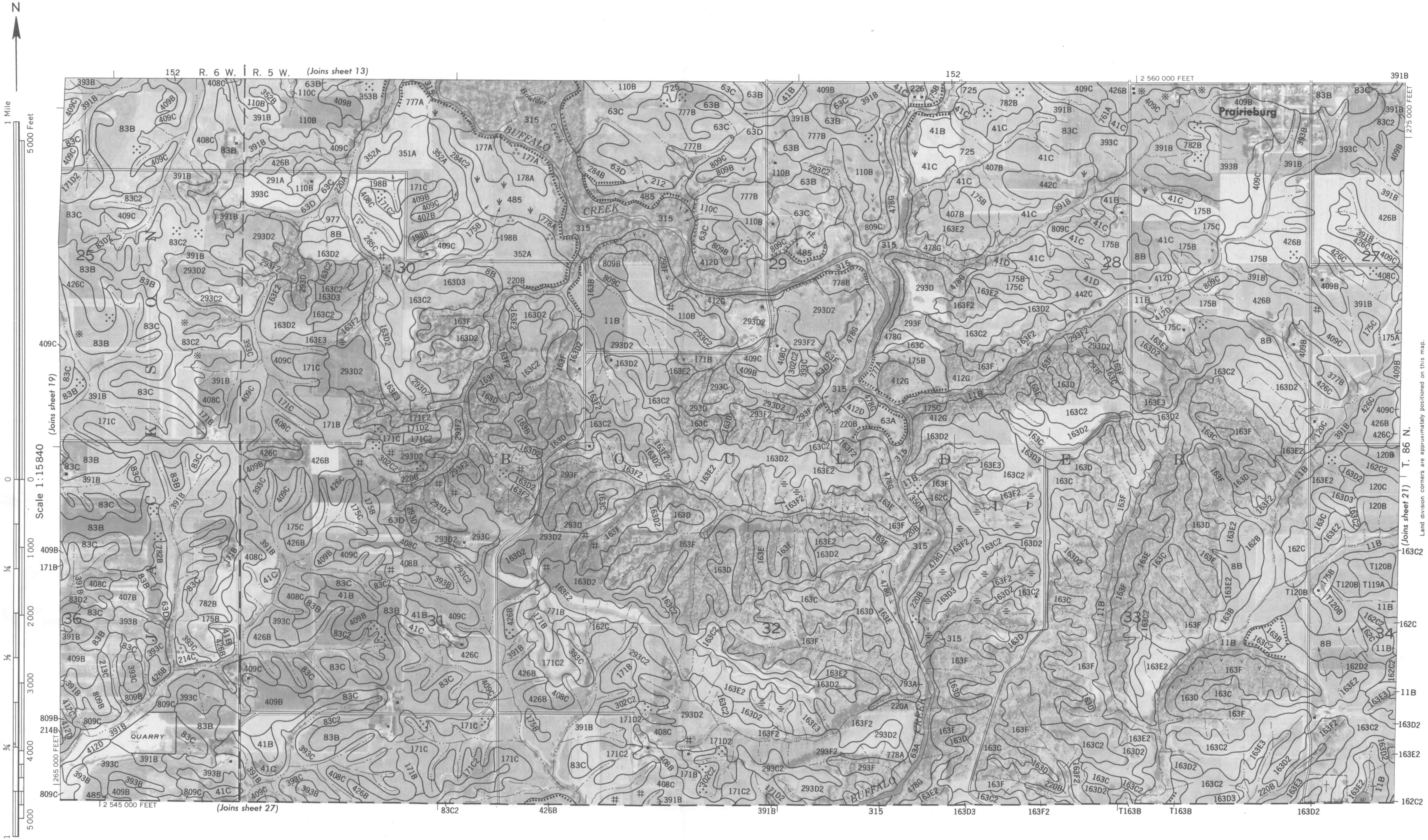
LINN COUNTY, IOWA NO. 17


N
Scale 1:15840
1 Mile
5000 Feet
(Joins sheet 11)
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 25)
R. 7 W.
R. 6 W.
T. 86 N.
2 520 000 FEET
2 505 000 FEET
265 000 FEET
270 000 FEET
S P R I N G G R O V E
J A C K S O N
Paris
Justins Creek
BLODGETT CEMETERY
25
26
29
30
31
32
35
36

19

N


R. 6 W.
T. 86 N.
(Joins sheet 12)
(Joins sheet 20)
(Joins sheet 26)
(Joins sheet 18)
2 525 000 FEET
2 540 000 FEET
270 000 FEET
265 000 FEET
QUARRY
WAPSIPINICON RIVER
PINICON RIDGE COUNTY PARK
J A C K S O N
ILLINOIS CENTRAL
OAKHILL CEMETERY
Central City
Scale 1:15 840
1 Mile
5000 Feet



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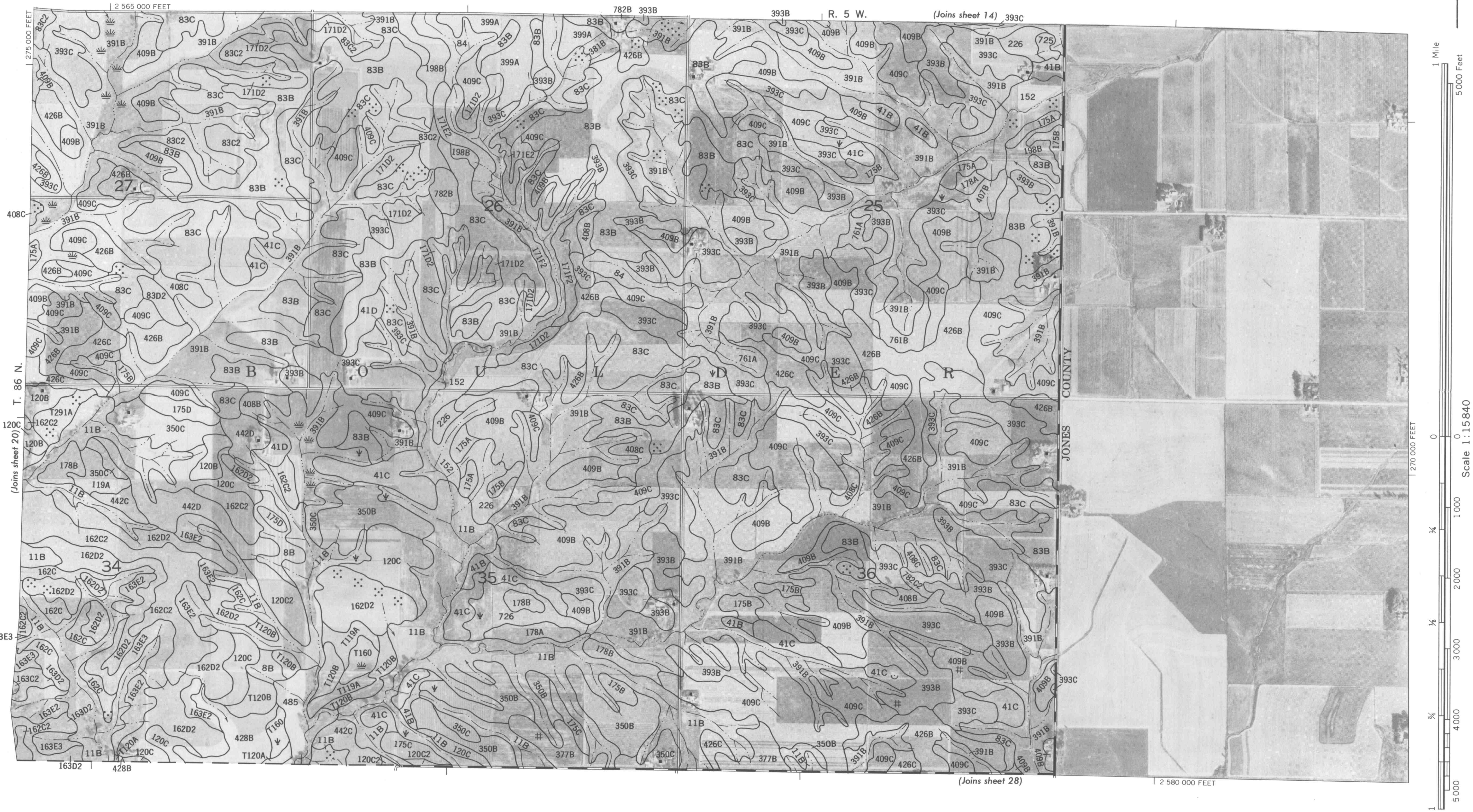

LINN COUNTY, IOWA NO. 21

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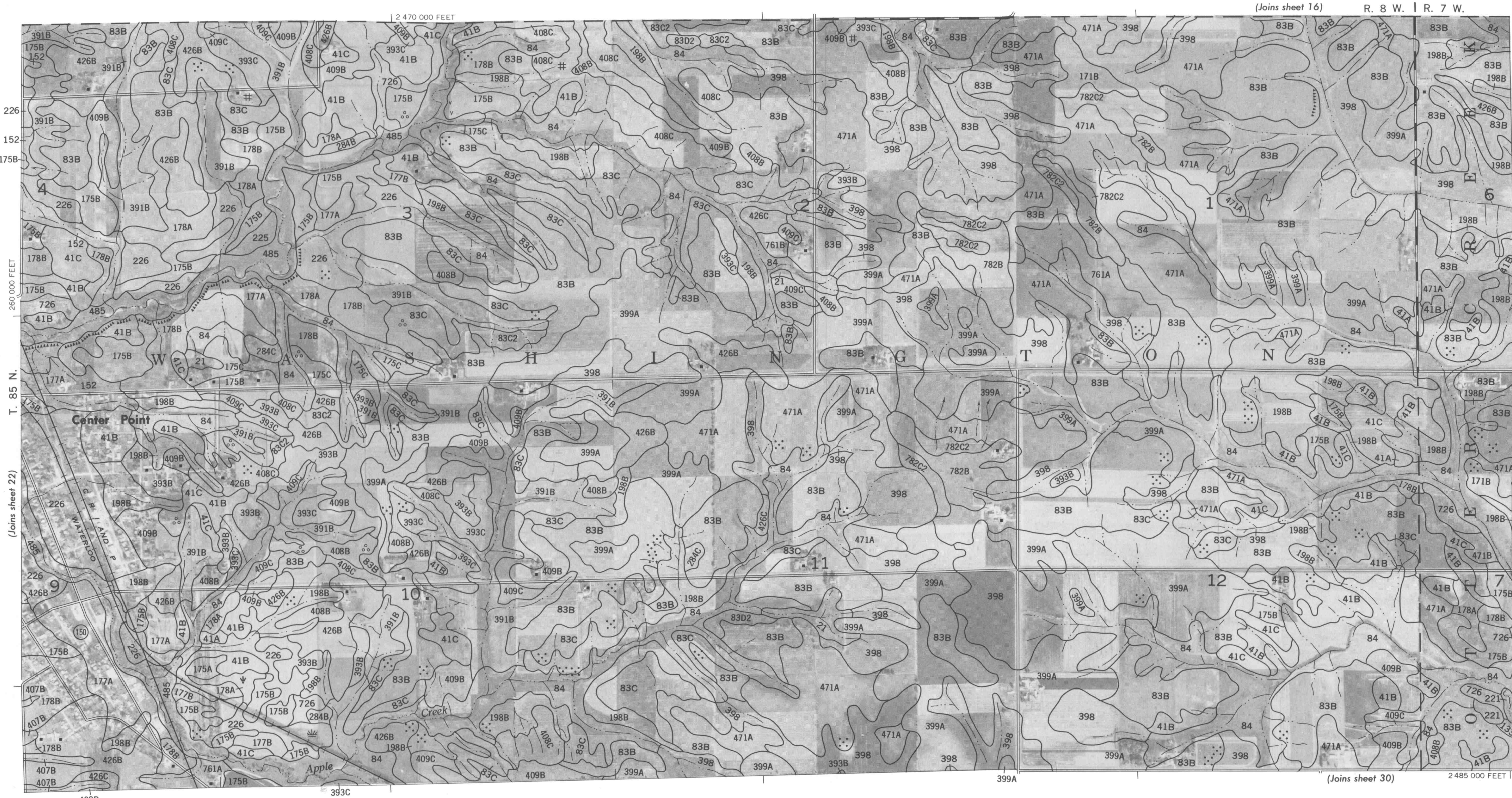
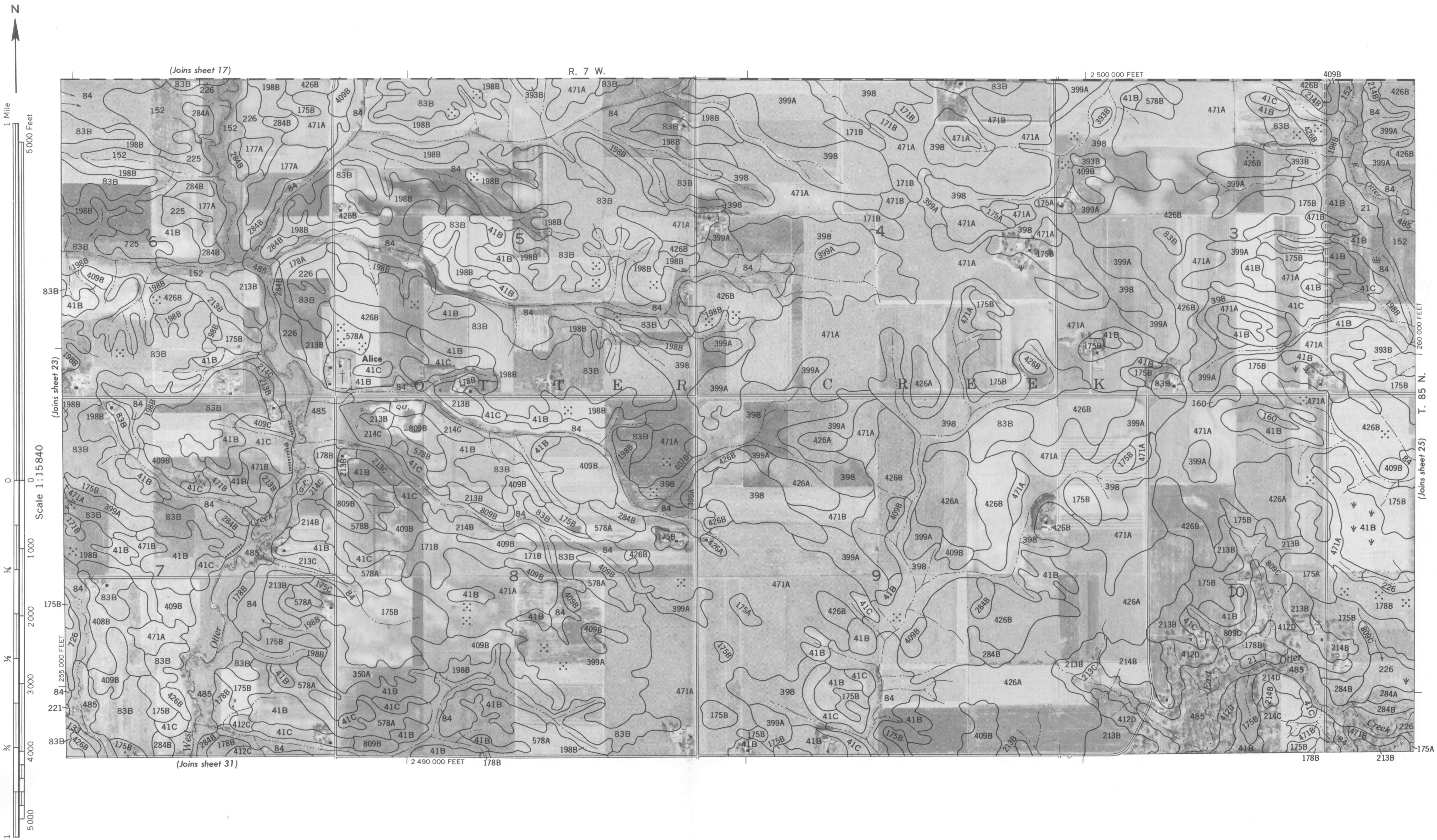
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.
Land division corners are approximately positioned on this map.

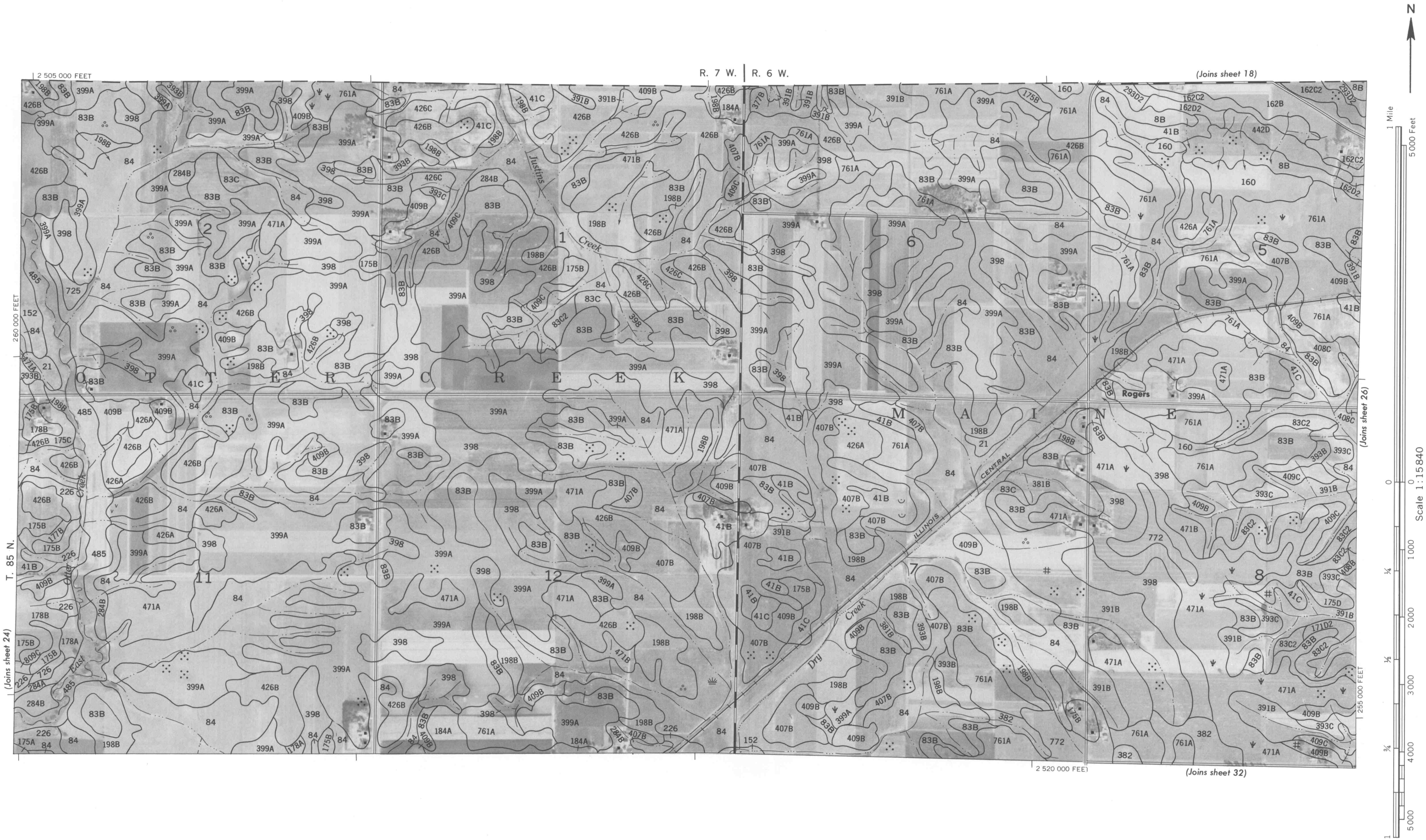

N
1 Mile
5000 Feet
Scale 1:15 840
R. 8 W.
(Joins sheet 15)
(Joins sheet 29)
(Joins sheet 23)
T. 85 N.
2 465 000 FEET
260 000 FEET
255 000 FEET
2 450 000 FEET
BENTON COUNTY
W A S H I N G T O N
Center Point
Golf Course
WATERLOO
Blue Creek
East Branch
Apple Creek
CHICAGO ROCK ISLAND AND PACIFIC
SEWAGE PLANT
MADE LAND

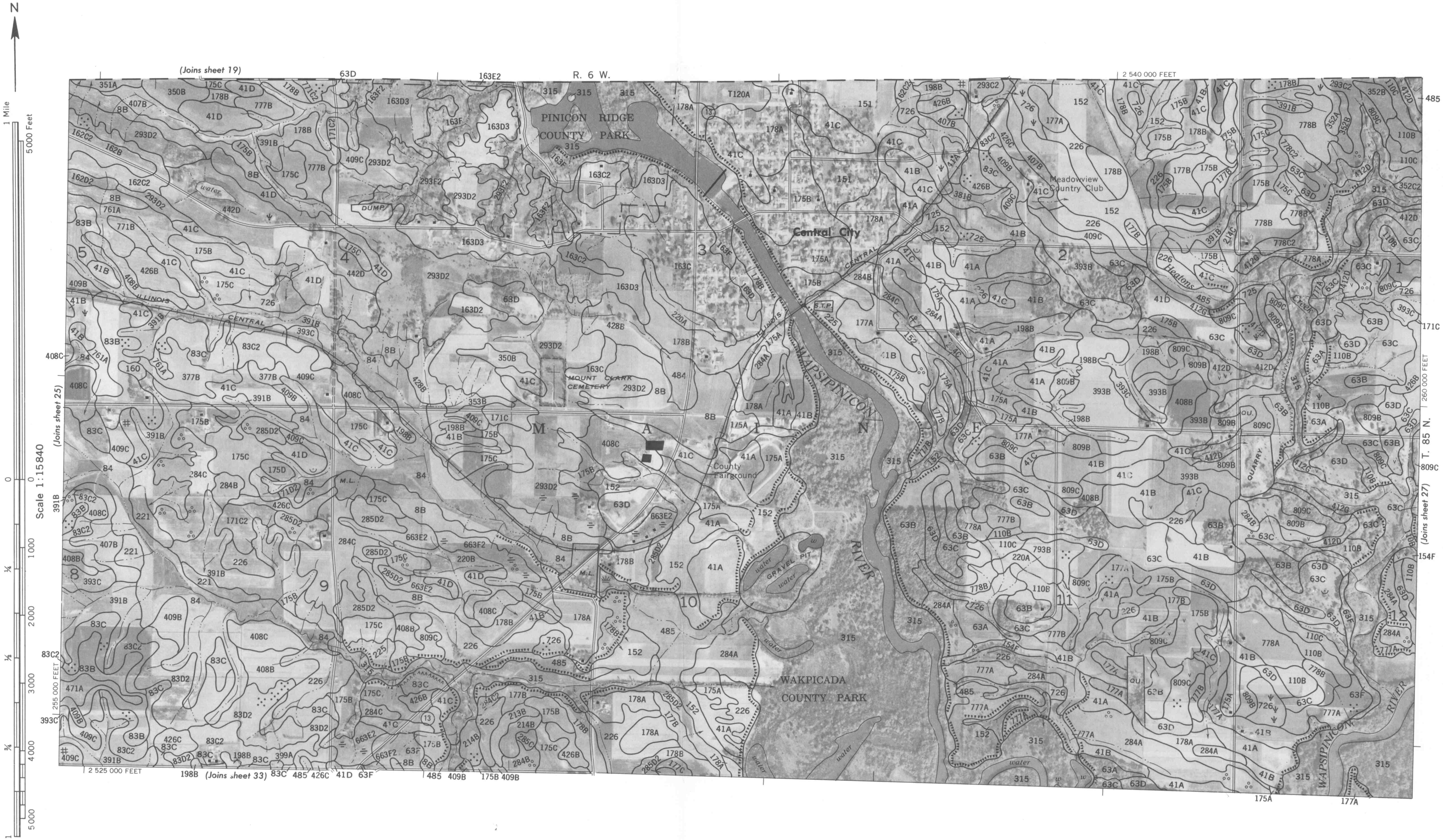
N

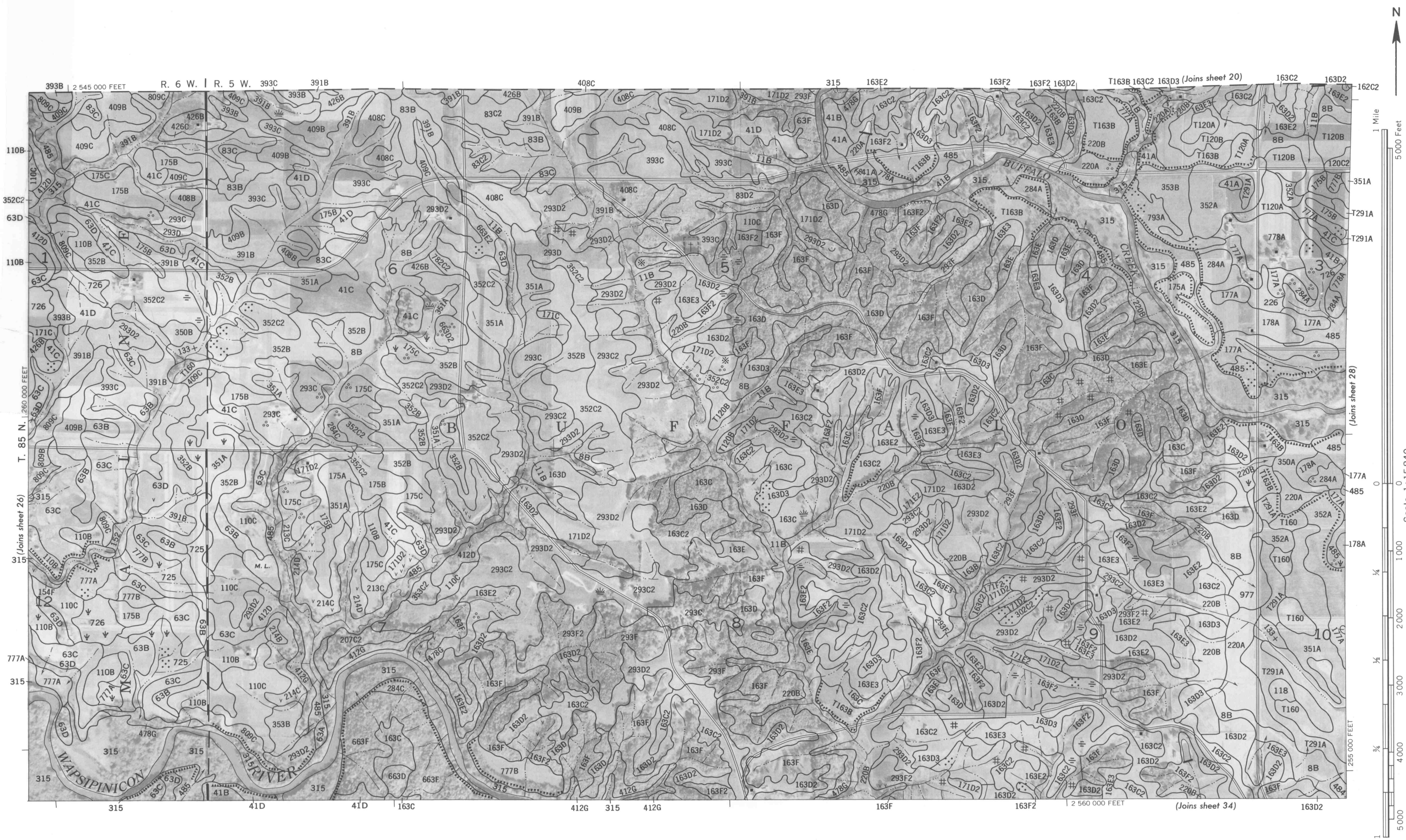


1 Mile
5000 Feet
0
Scale 1:15840
0
1000
2000
3000
4000
5000
¼
½
¾
1

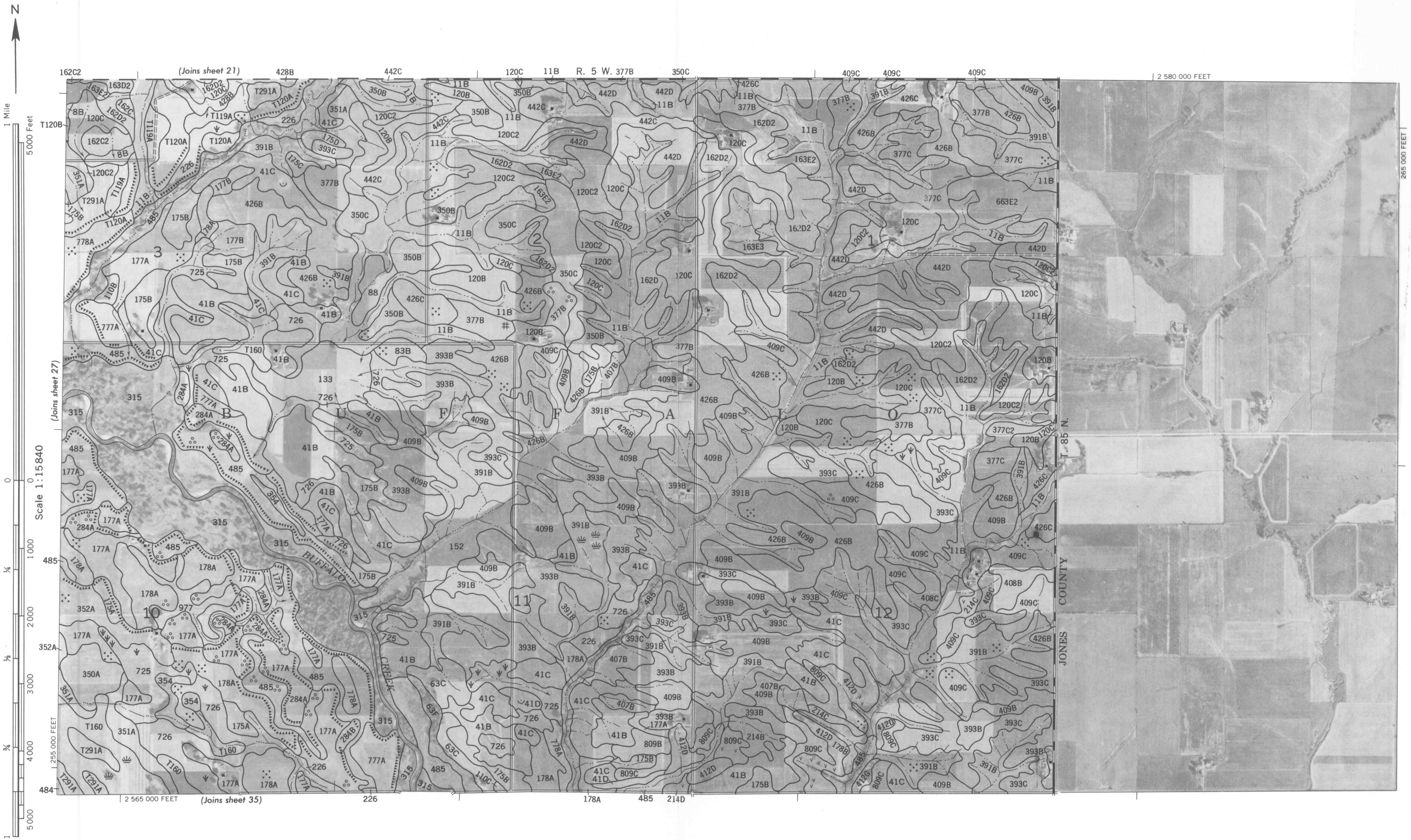

N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 17)
R. 7 W.
2 500 000 FEET
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 31)
2 490 000 FEET
255 000 FEET
260 000 FEET
T. 85 N.
Alice
O T T E R C R E E K
West Otter Creek
East Otter Creek
6
5
4
3
7
8
9
10


N
R. 7 W.
R. 6 W.
(Joins sheet 18)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 32)
2 505 000 FEET
2 520 000 FEET
260 000 FEET
255 000 FEET
T. 85 N.
O T T E R C R E E K
M A I N E
Rogers
Justins Creek
Dry Creek
ILLINOIS CENTRAL
Otter Creek
East
Scale 1:15 840
1 Mile
5 000 Feet


N
Scale 1:15840
1 Mile
5000 Feet
(Joins sheet 19)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 33)
R. 6 W.
T. 85 N.
2 540 000 FEET
2 525 000 FEET
255 000 FEET
260 000 FEET
PINICON RIDGE COUNTY PARK
Central City
Meadowview Country Club
MOUNT CLARK CEMETERY
County Fairground
GRAVEL PIT
WAKPICADA COUNTY PARK
WAPSIPINICON RIVER
ILLINOIS CENTRAL
Heatons Creek
DUMP
QUARRY
S.T.P.
water



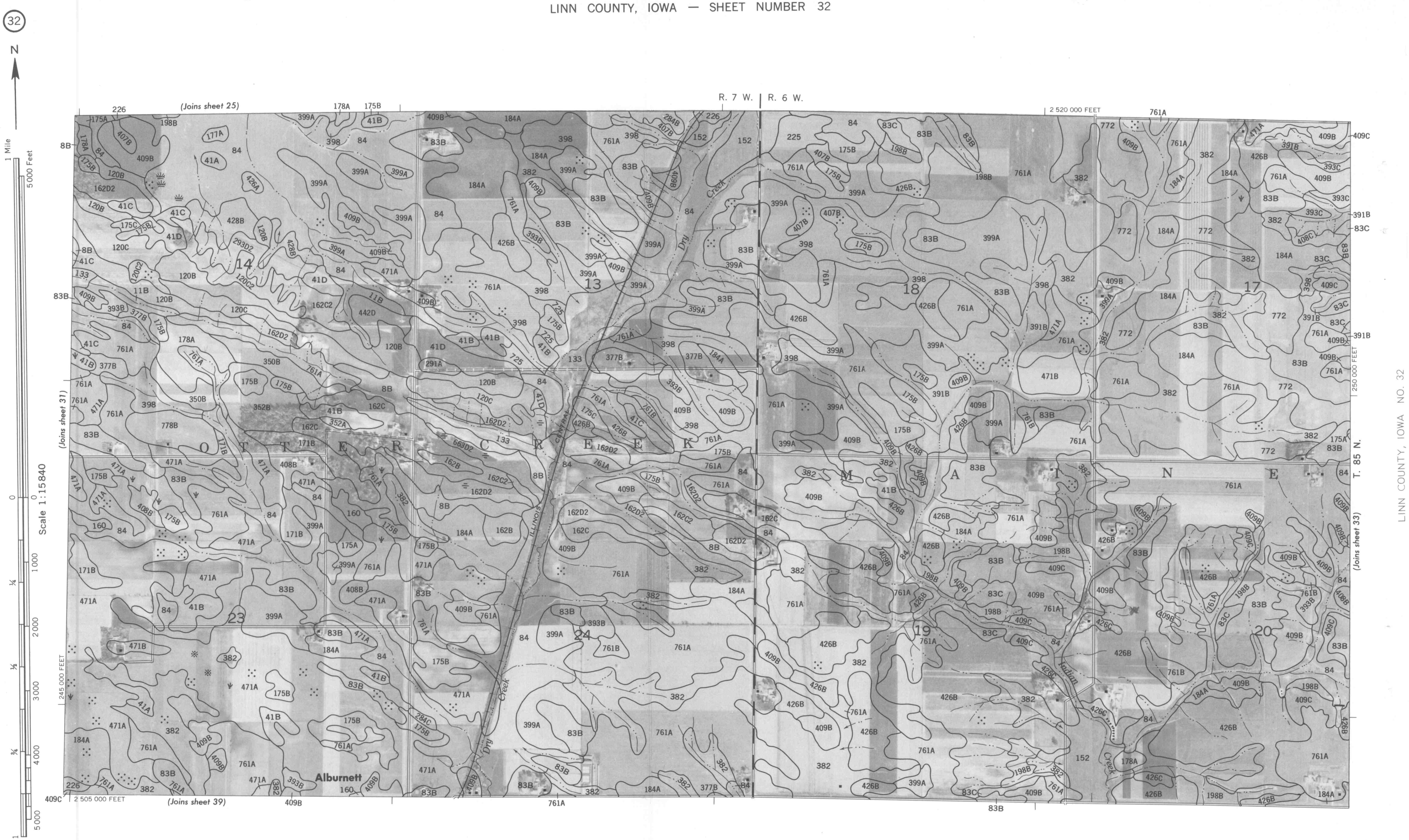
LINN COUNTY, IOWA NO. 27


N
1 Mile
5 000 Feet
Scale 1:15840
(Joins sheet 21)
(Joins sheet 27)
(Joins sheet 35)
R. 5 W.
T. 85 N.
BUFFALO CREEK
JONES COUNTY
2 580 000 FEET
2 565 000 FEET
255 000 FEET
265 000 FEET
1
2
3
10
11
12

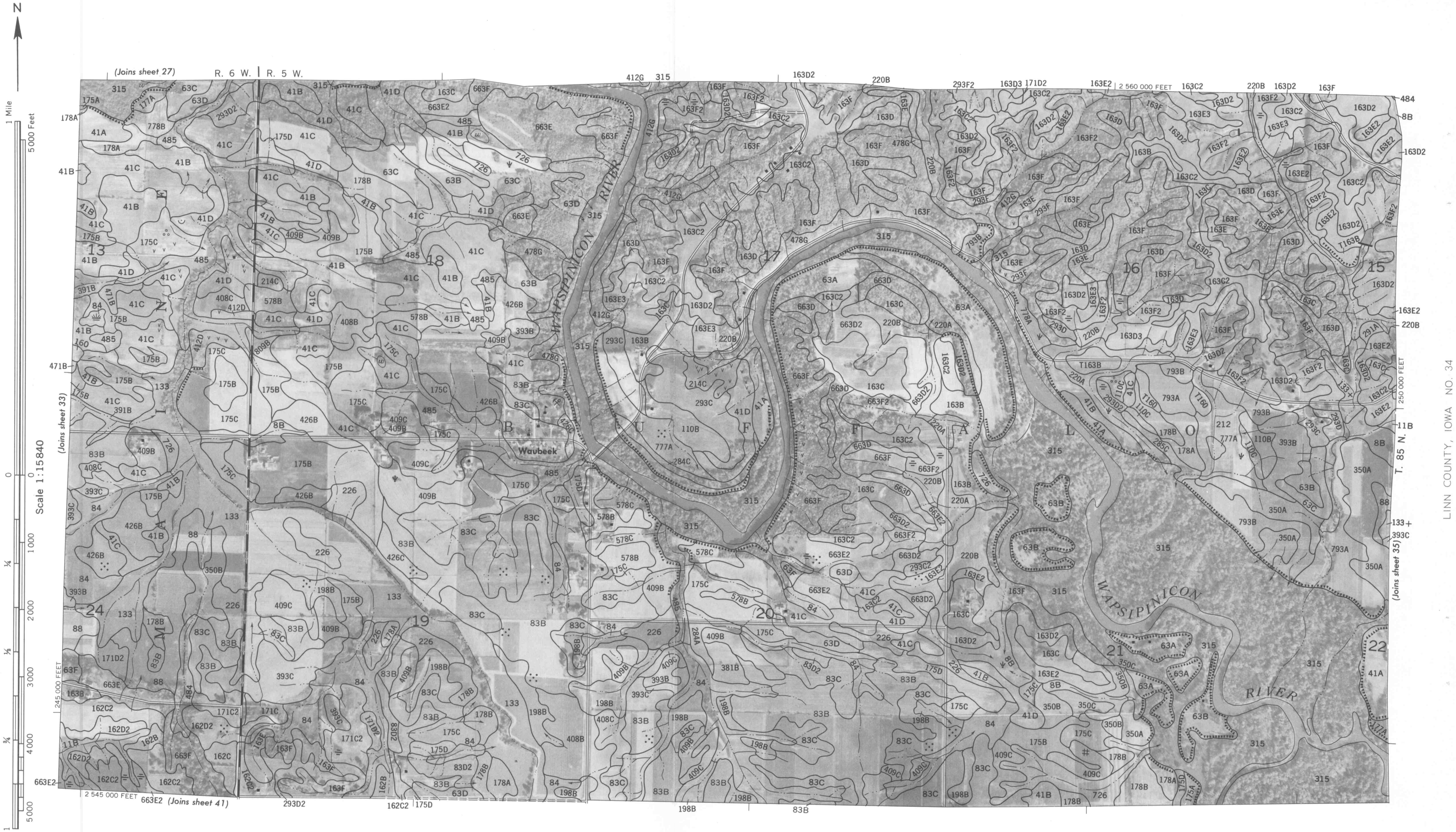

N
2 450 000 FEET
R. 8 W.
(Joins sheet 22)
250 000 FEET
T. 85 N.
BENTON COUNTY
WASHINGTON
FAYETTE
CEDAR RIVER
INDEFINITE BOUNDARY
Blue Creek
QUARRY
18
17
16
19
20
21
Lewis Bottoms Access
County Park
(Joins sheet 30)
245 000 FEET
2 465 000 FEET
(Joins sheet 36)
1 Mile
5000 Feet
Scale 1:15840


N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 23)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 37)
R. 8 W. | R. 7 W.
T. 85 N.
2 485 000 FEET
250 000 FEET
245 000 FEET
2 470 000 FEET
CHICAGO ROCK ISLAND AND PACIFIC
WATERLOO
Nelson Creek
West Otter Creek
W A S H I N G T O N
LINN COUNTY, IOWA NO. 30


R. 7 W.
T. 85 N.
(Joins sheet 24)
(Joins sheet 32)
(Joins sheet 38)
(Joins sheet 30)
2 490 000 FEET
2 500 000 FEET
250 000 FEET
245 000 FEET
N
Scale 1:15840
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
O T T E R C R E E K
Otter Creek
West Otter Creek
East Otter Creek
WATERLOO
15
16
17
18
19
20
21
22
S.P.


32
N
Scale 1:15840
1 Mile
5 000 Feet
(Joins sheet 25)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 39)
R. 7 W.
R. 6 W.
T. 85 N.
2 520 000 FEET
2 505 000 FEET
250 000 FEET
245 000 FEET
O T T E R C R E E K
M A I N E
Alburnett
Dry Creek
Indian Creek
ILLINOIS CENTRAL
13
14
17
18
19
20
23
24
LINN COUNTY, IOWA NO. 32


N
315
R. 6 W.
284A (Joins sheet 26)
2 525 000 FEET
WAKPICADA
COUNTY PARK
WAPSIPINICON RIVER
water
T. 85 N.
250 000 FEET
(Joins sheet 32)
(Joins sheet 34)
M A I N E
Wassmer
Landing Strip
Jordans Grove
2 540 000 FEET
(Joins sheet 40)
245 000 FEET
1 Mile
5000 Feet
Scale 1:15840
0
1000
2000
3000
4000
5000

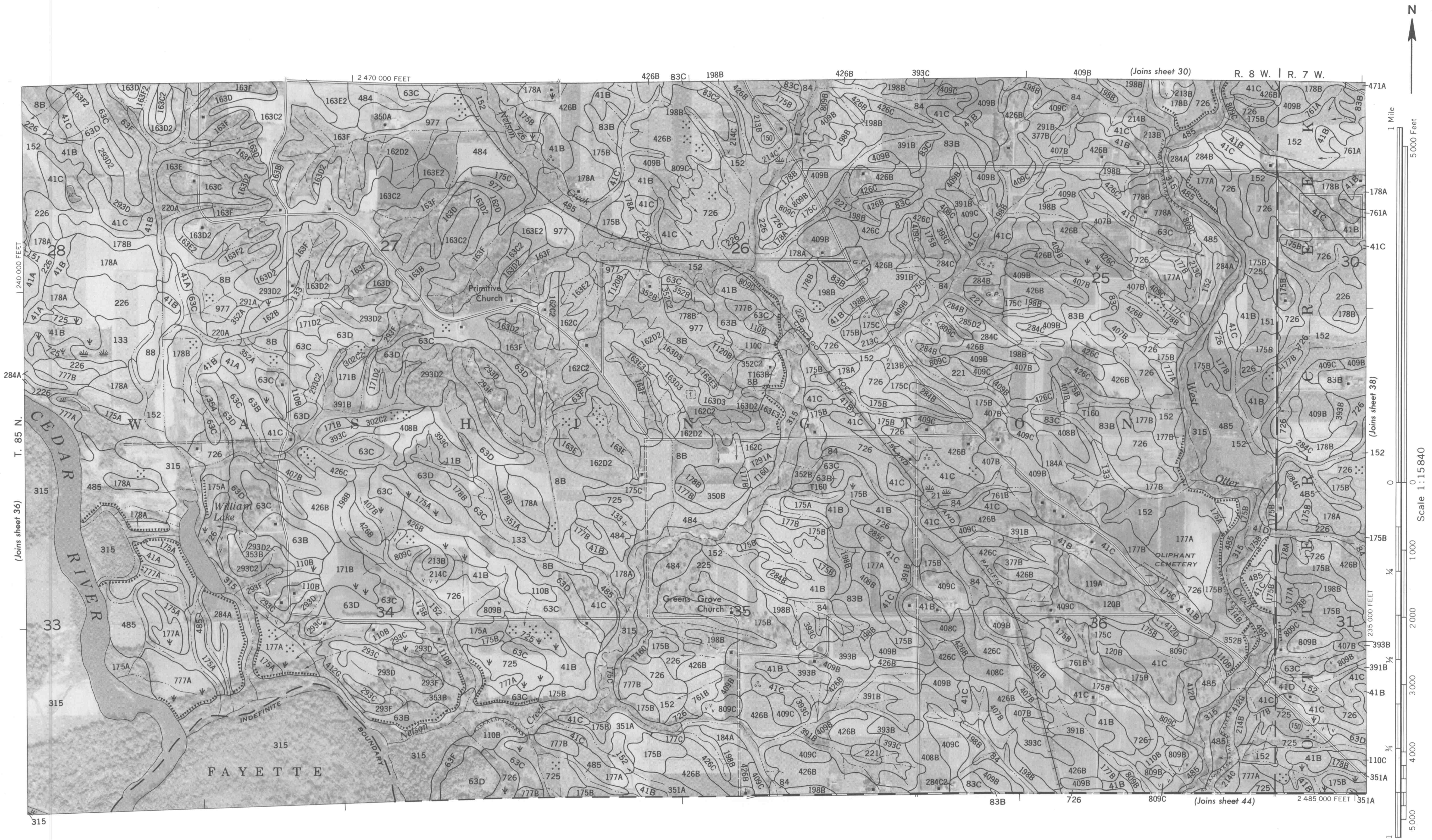

N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 27)
R. 6 W.
R. 5 W.
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 41)
T. 85 N.
2 560 000 FEET
2 545 000 FEET
250 000 FEET
245 000 FEET
WAPSIPINICON RIVER
WAPSIPINICON RIVER
Waubeek
13
15
16
17
18
19
20
21
22
24
LINN COUNTY, IOWA NO. 34

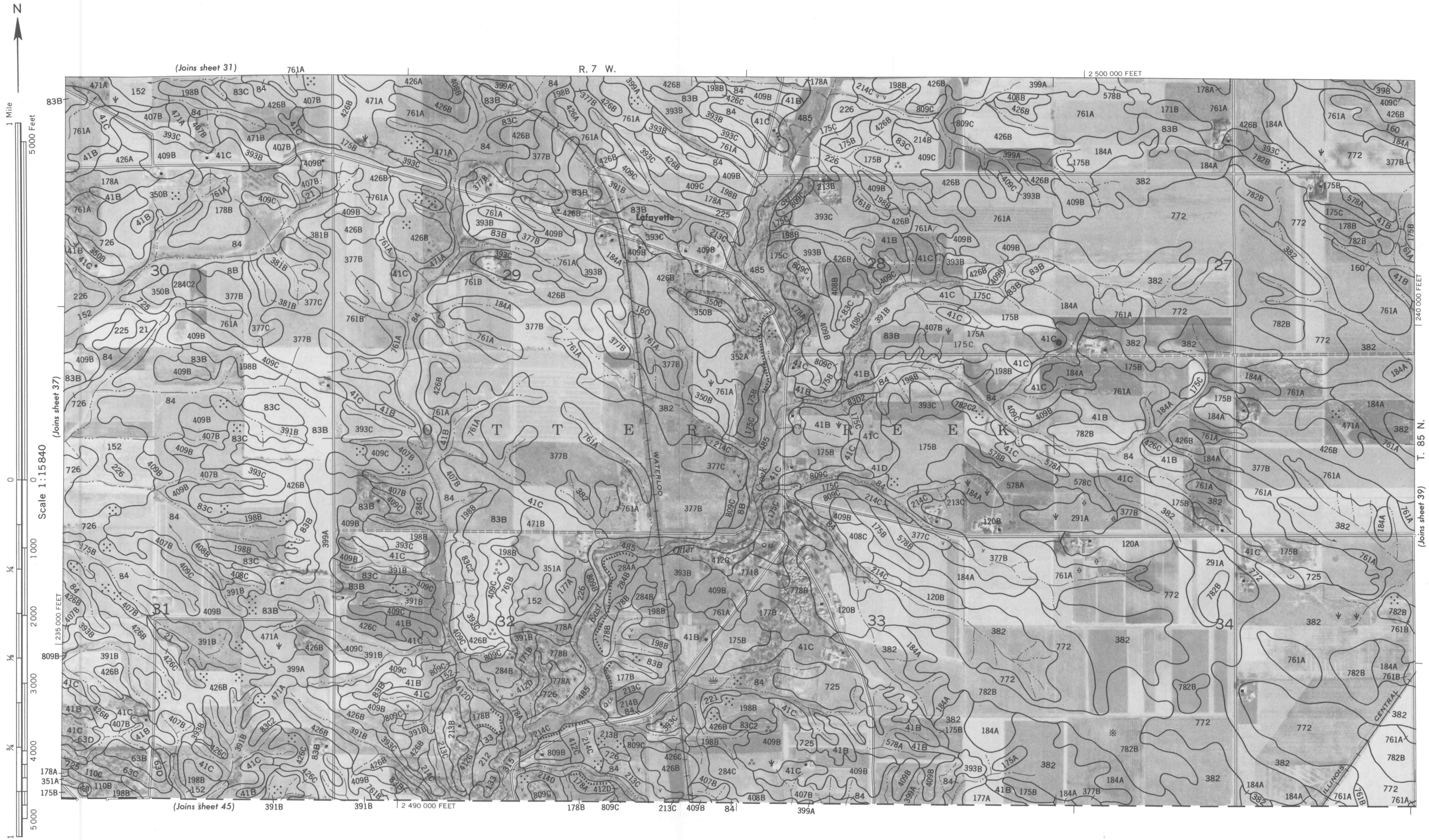
LINN COUNTY, IOWA NO. 35

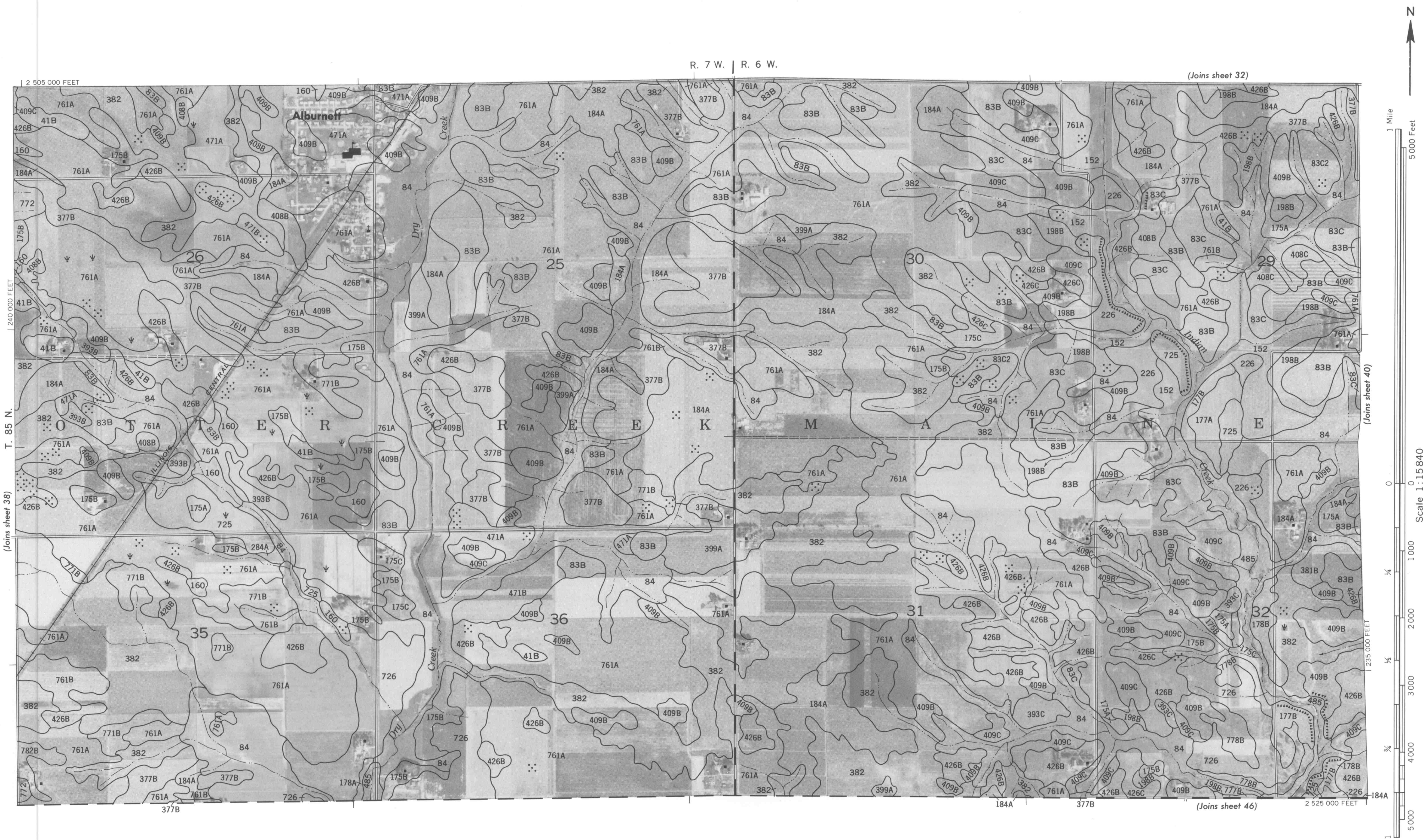
LINN COUNTY, IOWA — SHEET NUMBER 36

Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.

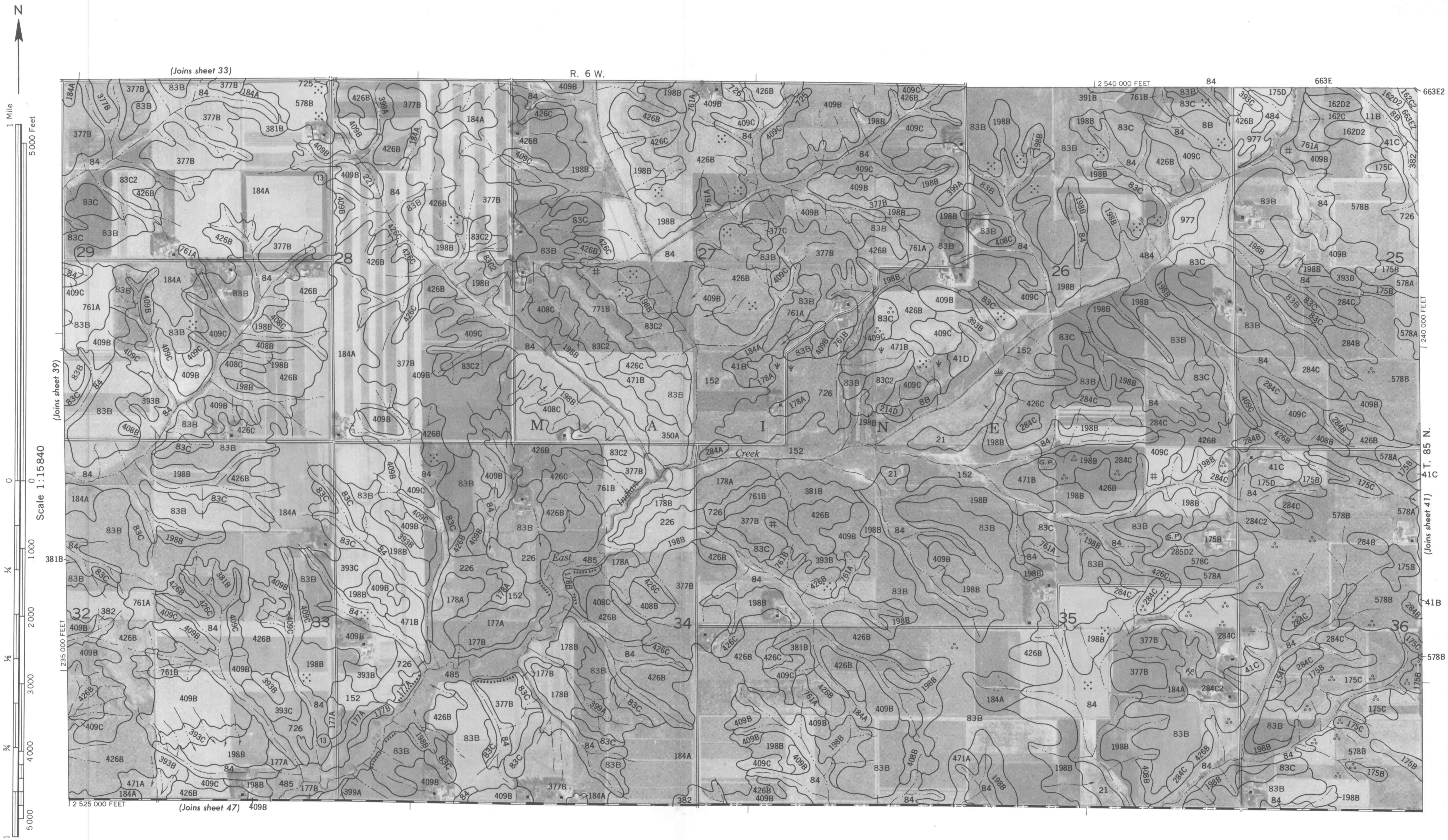
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

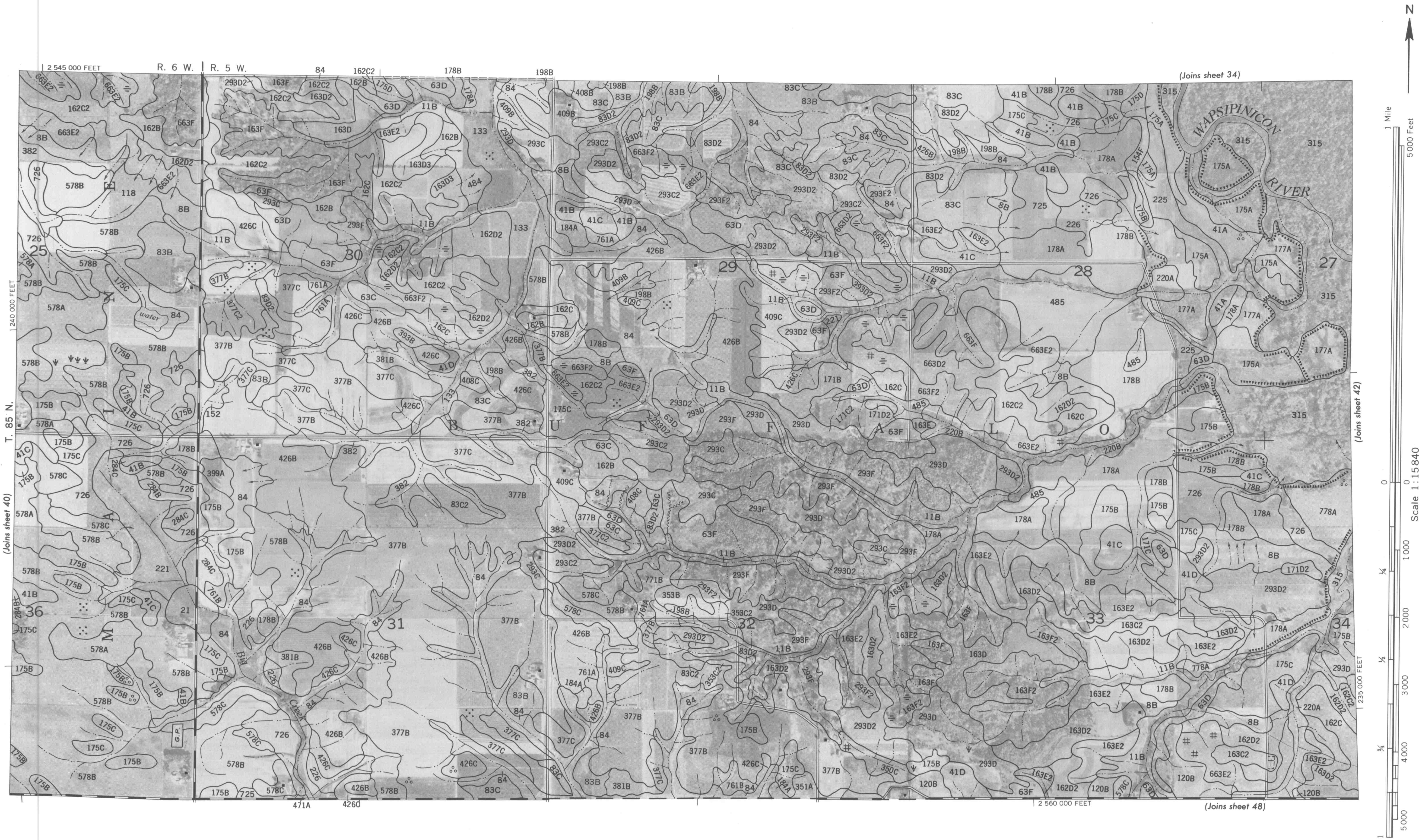

N
(Joins sheet 30)
R. 8 W.
R. 7 W.
2 470 000 FEET
240 000 FEET
T. 85 N.
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 44)
2 485 000 FEET
235 000 FEET
CEDAR RIVER
FAYETTE
INDEFINITE BOUNDARY
WASHINGTON
KENWOOD
Primitive Church
Greens Grove Church
OLIPHANT CEMETERY
William Lake
Nelson Creek
West Otter Creek
CHICAGO ROCK ISLAND AND PACIFIC
28
27
26
25
30
33
34
35
36
31
1 Mile
5000 Feet
Scale 1:15840


N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 31)
R. 7 W.
2 500 000 FEET
240 000 FEET
T. 85 N.
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 45)
235 000 FEET
2 490 000 FEET
Lafayette
O T T E R C R E E K
Otter Creek
WATERLOO
ILLINOIS CENTRAL
30
29
28
27
31
32
33
34


N
R. 7 W.
R. 6 W.
2 505 000 FEET
(Joins sheet 32)
240 000 FEET
235 000 FEET
2 525 000 FEET
(Joins sheet 38)
(Joins sheet 40)
(Joins sheet 46)
T. 85 N.
Alburnett
Dry Creek
Indian Creek
ILLINOIS CENTRAL
O T T E R C R E E K
M A I N E
25
26
29
30
31
32
35
36
1 Mile
5000 Feet
Scale 1:15840

LINN COUNTY, IOWA — SHEET NUMBER 40

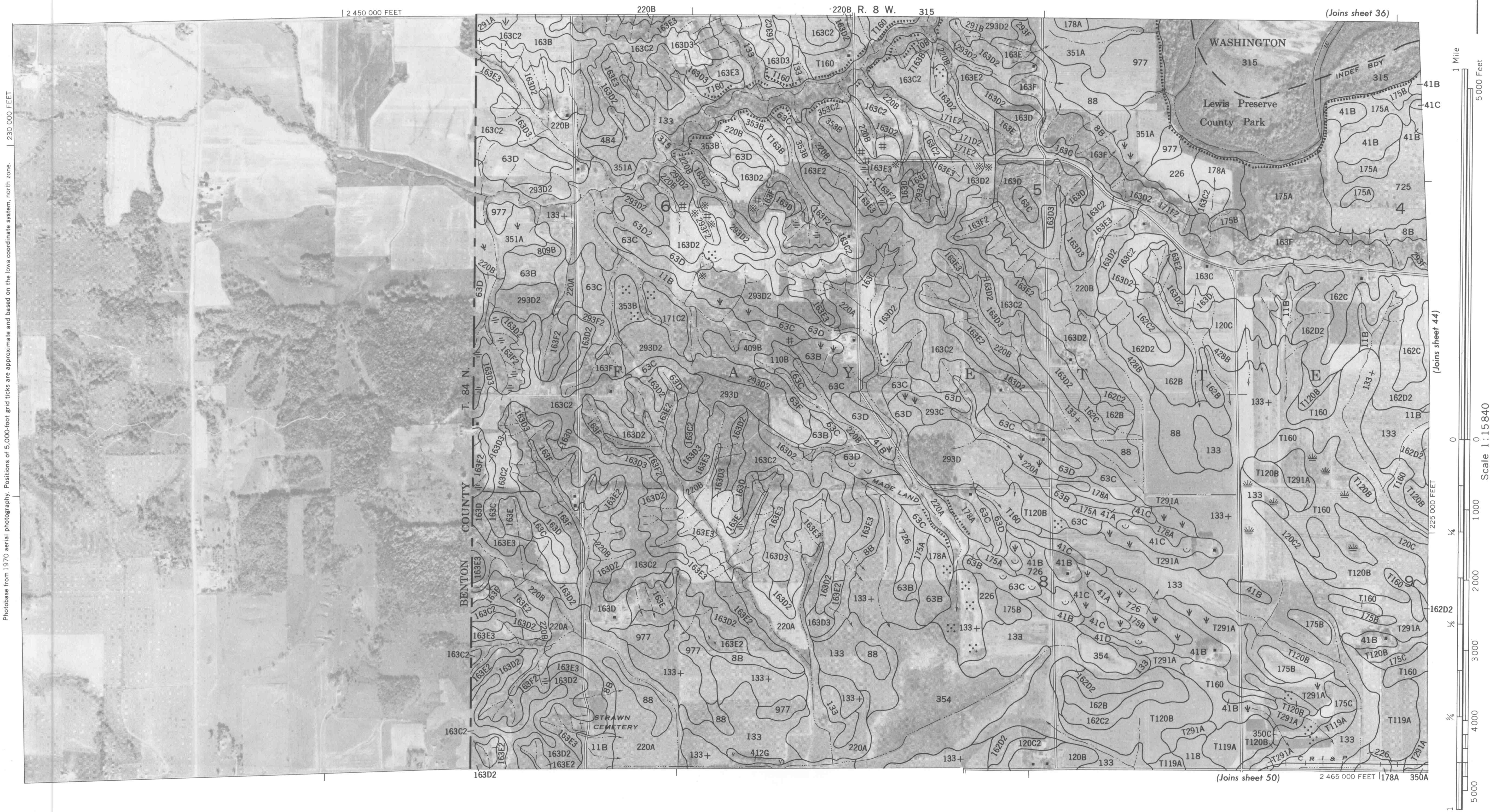



N
2 545 000 FEET
R. 6 W.
R. 5 W.
T. 85 N.
240 000 FEET
235 000 FEET
2 560 000 FEET
(Joins sheet 34)
(Joins sheet 40)
(Joins sheet 42)
(Joins sheet 48)
WAPSIPINICON
RIVER
Big
Creek
water
G.P.
B U F F A L O
25
30
29
28
27
36
31
32
33
34
1 Mile
5000 Feet
Scale 1:15840

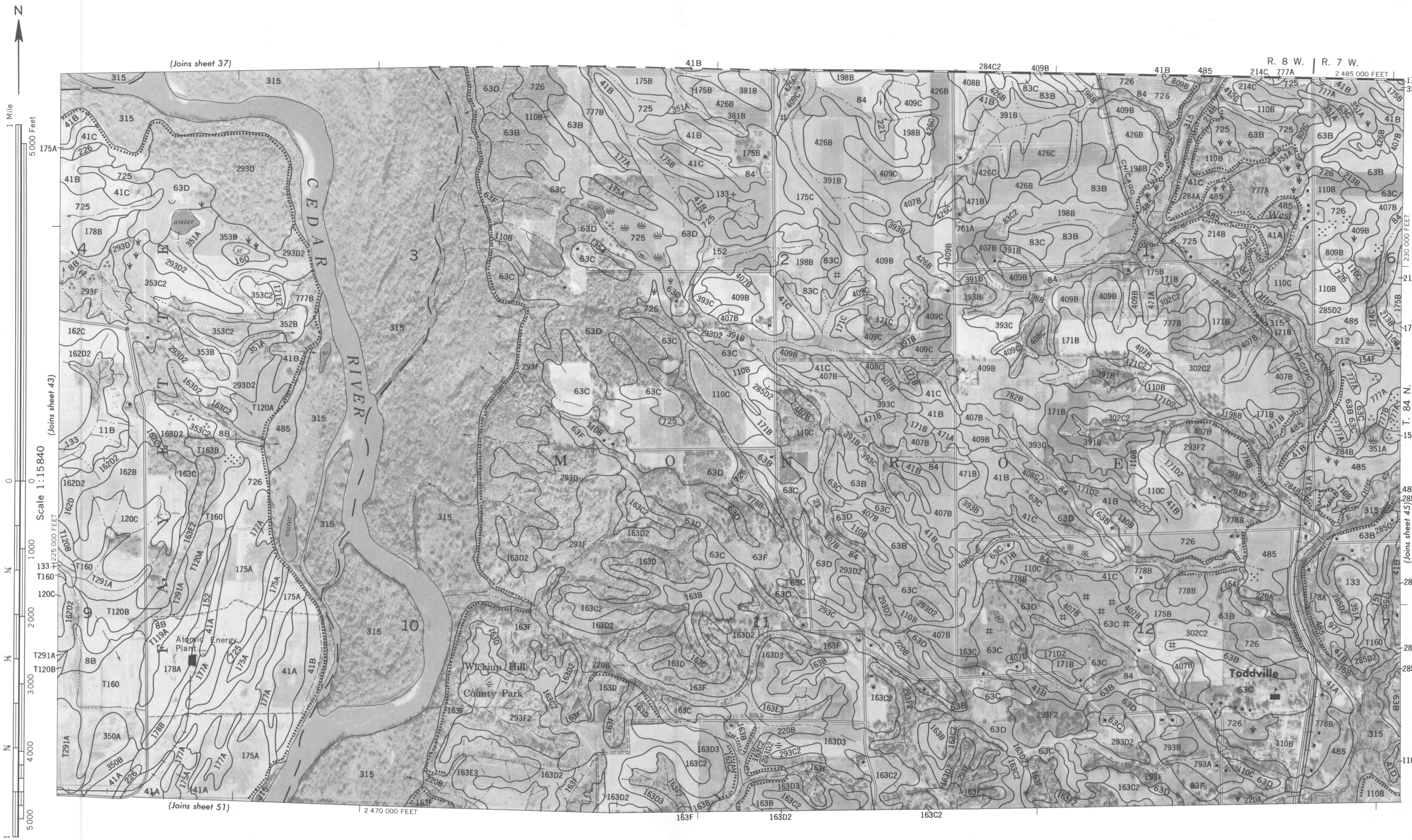

N
(Joins sheet 35)
R. 5 W.
(Joins sheet 41)
(Joins sheet 49)
T. 85 N.
JONES COUNTY
2 580 000 FEET
2 565 000 FEET
235 000 FEET
240 000 FEET
MATSELL BRIDGE
BUFFALO
GAME MANAGEMENT AREA
WAPSIPINICON RIVER
WAPSIPINICON
RIVER
water
26
27
25
34
35
36
Scale 1:15840
1 Mile
5000 Feet
1000
2000
3000
4000
5 000

LINN COUNTY, IOWA NO. 43

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.



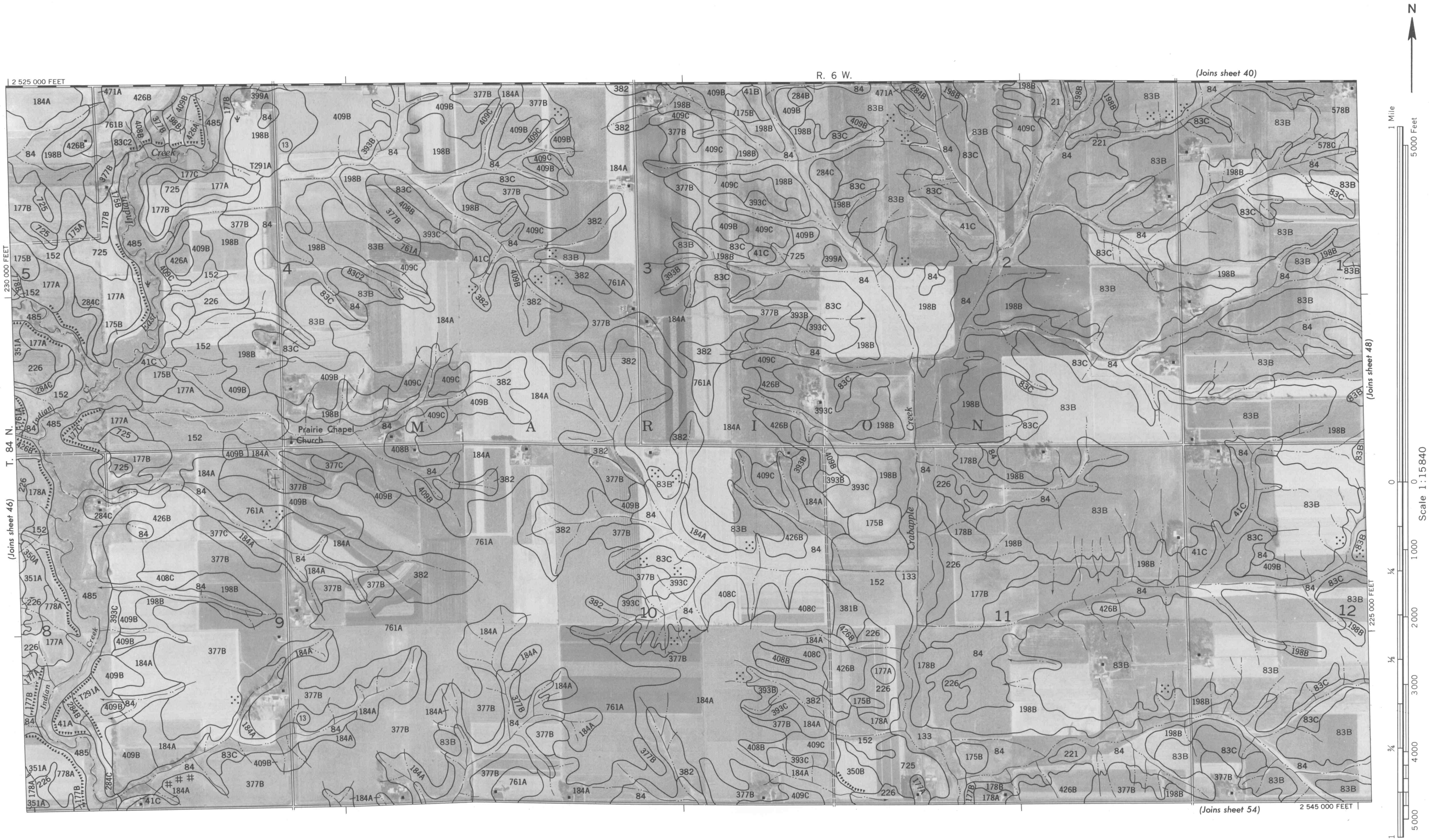
LINN COUNTY, IOWA — SHEET NUMBER 44



45

LINN COUNTY, IOWA NO. 45


N
1 Mile
5000 Feet
Scale 1:15840
0
1000
2000
3000
4000
5000
¼
½
¾
(Joins sheet 39)
(Joins sheet 45)
(Joins sheet 47)
(Joins sheet 53)
R. 7 W.
R. 6 W.
T. 84 N.
2 520 000 FEET
2 510 000 FEET
225 000 FEET
230 000 FEET
M A R I O N
Dry Creek
Indian Creek
Berrys Run
1
2
5
6
7
8
11
12


N
2 525 000 FEET
R. 6 W.
(Joins sheet 40)
(Joins sheet 48)
(Joins sheet 46)
(Joins sheet 54)
2 545 000 FEET
230 000 FEET
225 000 FEET
T. 84 N.
M A R I O N
Prairie Chapel Church
Indian Creek
Indian Creek
East Creek
Crabapple Creek
Scale 1:15840
1 Mile
5000 Feet


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 41)
R. 6 W.
R. 5 W.
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 55)
T. 84 N.
2 560 000 FEET
2 550 000 FEET
230 000 FEET
225 000 FEET
MARION
BROWN
Big Creek
QUARRY
Whittier
1
2
3
4
5
6
7
8
9
10
12

LINN COUNTY, IOWA NO. 49

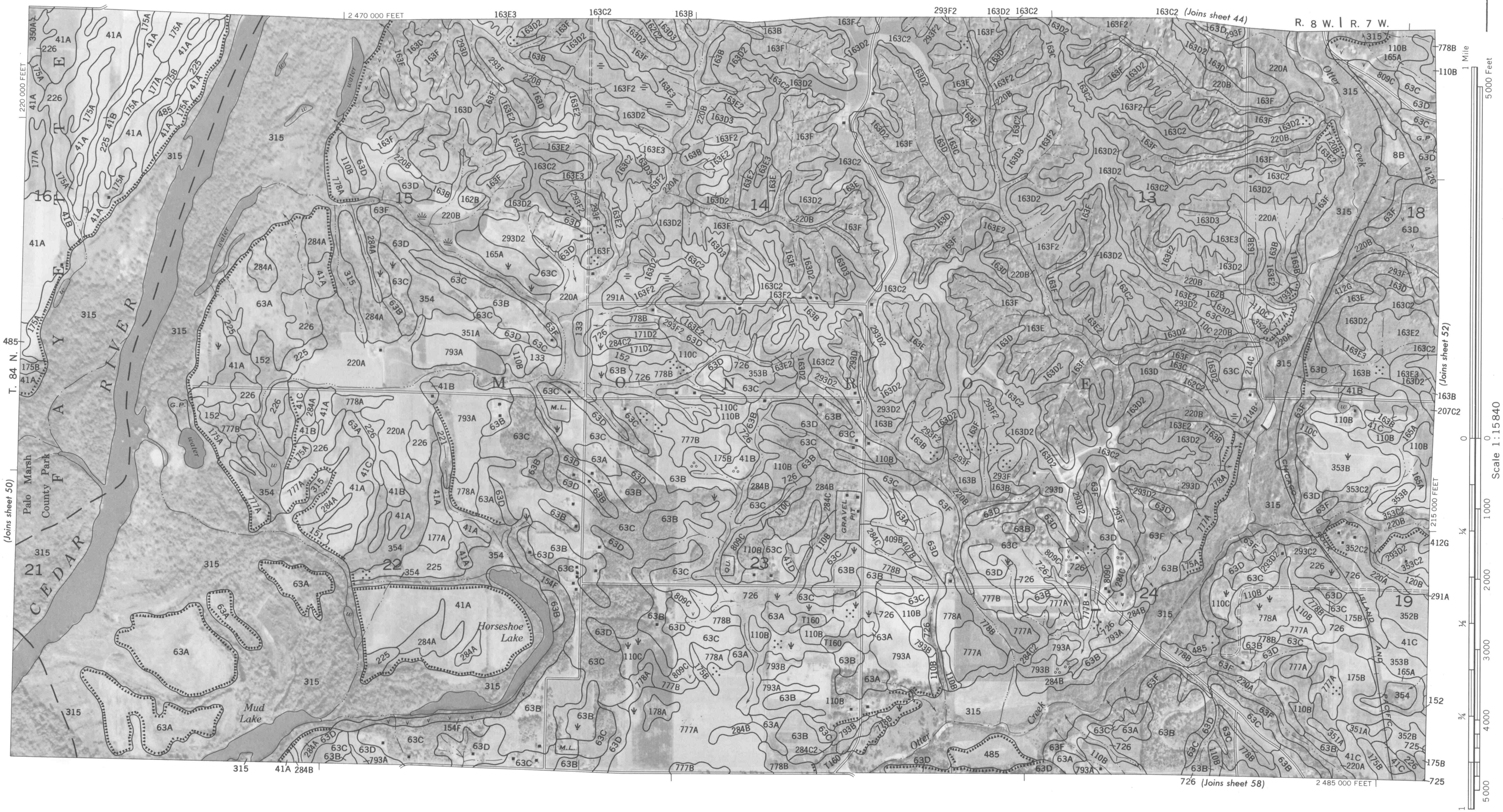
N

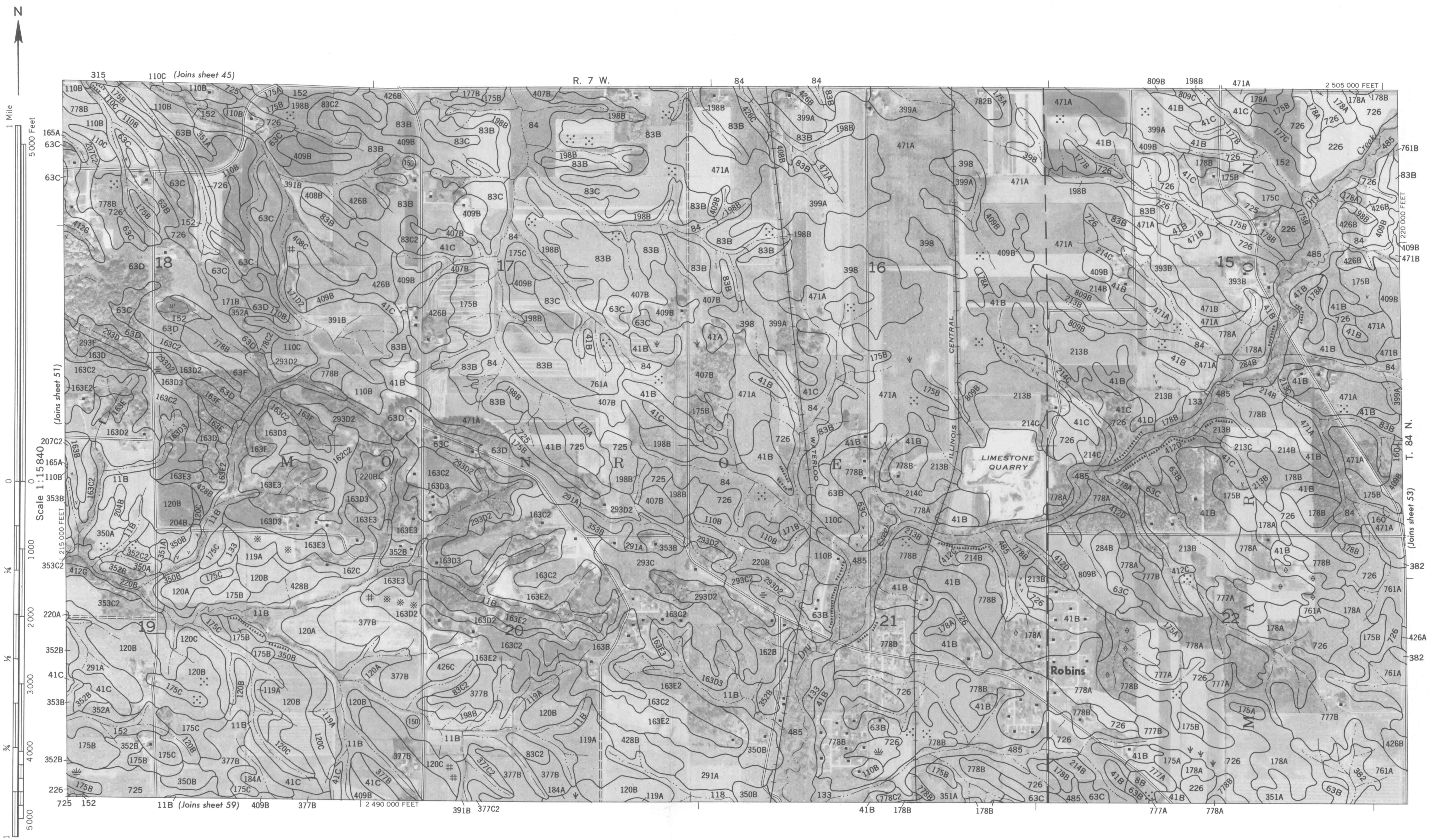
Scale 1:15840

1 Mile

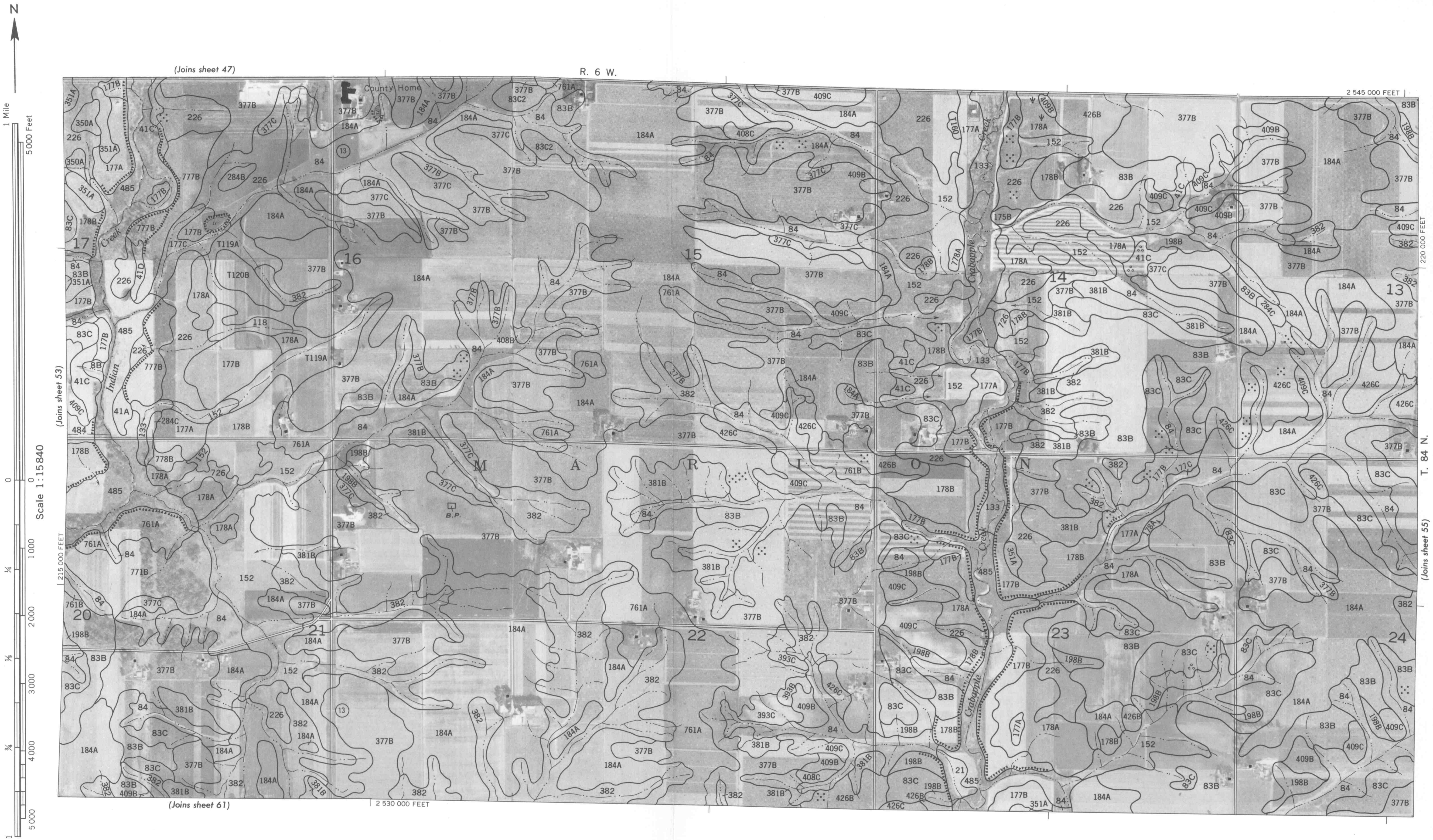
5 000 Feet

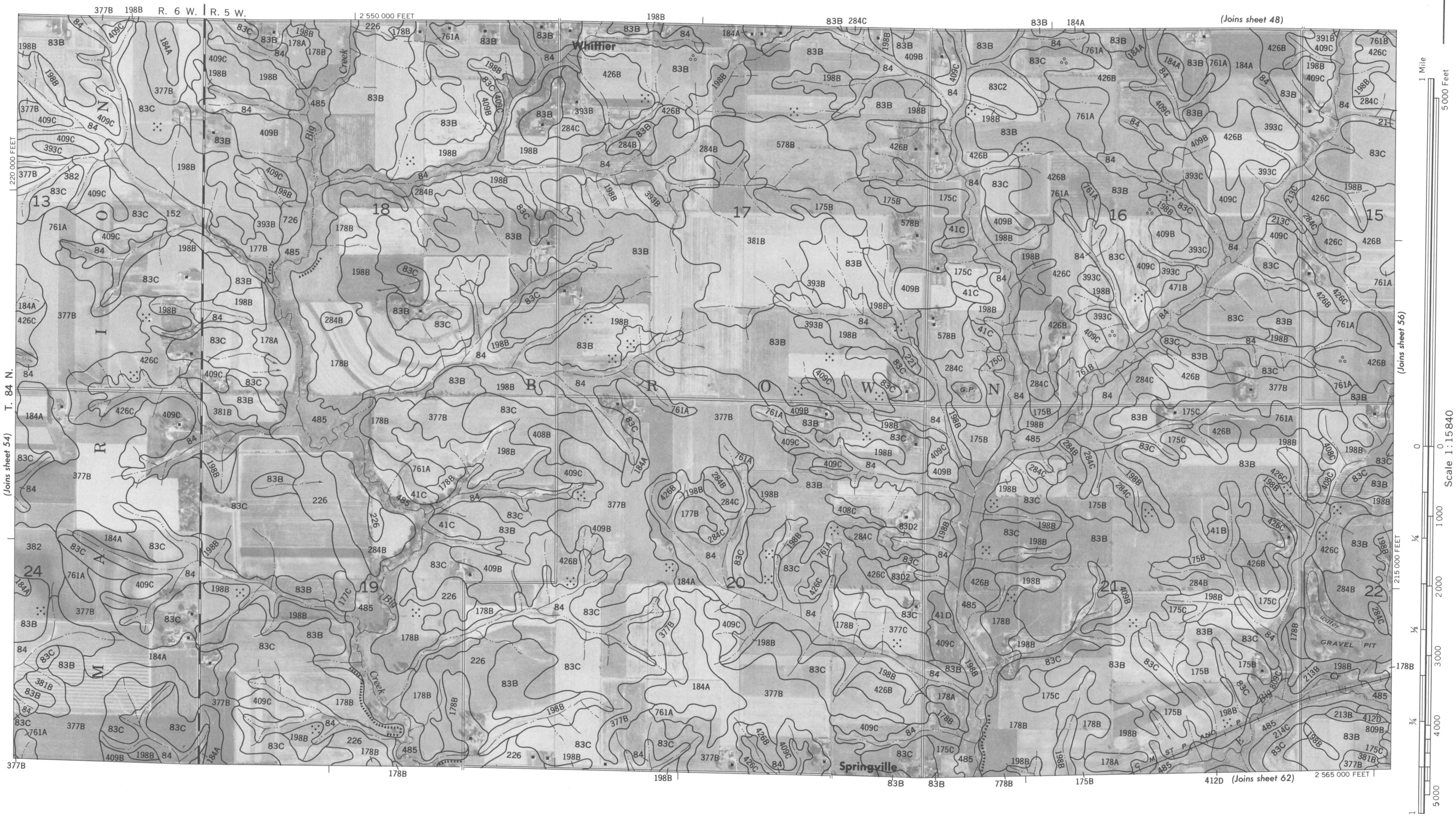

N
1 Mile
5000 Feet
Scale 1:15 840
R. 8 W.
(Joins sheet 43)
(Joins sheet 51)
(Joins sheet 57)
T. 84 N.
2 465 000 FEET
2 450 000 FEET
220 000 FEET
215 000 FEET
BENTON COUNTY
FAYETTE
Bear Creek
QUARRY
CHICAGO ROCK ISLAND AND PACIFIC
OLD PALO CEMETERY
Palo Marsh County Park
Palo
CEDAR R
18
17
16
19
20
21


51
N
(Joins sheet 44)
(Joins sheet 50)
(Joins sheet 52)
(Joins sheet 58)
R. 8 W. | R. 7 W.
T. 84 N.
2 470 000 FEET
2 485 000 FEET
220 000 FEET
215 000 FEET
MONROE
FAYETTE
CEDAR RIVER
Palo Marsh County Park
Horseshoe Lake
Mud Lake
Otter Creek
CHICAGO, ROCK ISLAND AND PACIFIC
GRAVEL PIT
Scale 1:15840
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
R. 7 W.
T. 84 N.
(Joins sheet 45)
(Joins sheet 51)
(Joins sheet 53)
11B (Joins sheet 59)
2 505 000 FEET
220 000 FEET
215 000 FEET
2 490 000 FEET
Scale 1:15840
1 Mile
5 000 Feet
M O N R O E
LIMESTONE QUARRY
Robins
Dry Creek
WATERLOO
CENTRAL ILLINOIS
18
17
16
15
19
20
21
22


N
R. 7 W.
R. 6 W.
2 510 000 FEET
(Joins sheet 46)
220 000 FEET
T. 84 N.
(Joins sheet 52)
(Joins sheet 54)
215 000 FEET
(Joins sheet 60)
2 525 000 FEET
M A R I O N
14
13
18
17
23
24
19
20
Berry's Run
Indian Creek
1 Mile
5000 Feet
Scale 1:15 840
LINN COUNTY, IOWA NO. 53


N
Scale 1:15 840
1 Mile
5 000 Feet
0
1000
2000
3000
4000
5 000
(Joins sheet 47)
R. 6 W.
County Home
2 545 000 FEET
220 000 FEET
215 000 FEET
2 530 000 FEET
(Joins sheet 53)
(Joins sheet 55)
(Joins sheet 61)
T. 84 N.
M A R I O N
Indian Creek
Crabapple Creek
B.P.
13
14
15
16
17
20
21
22
23
24

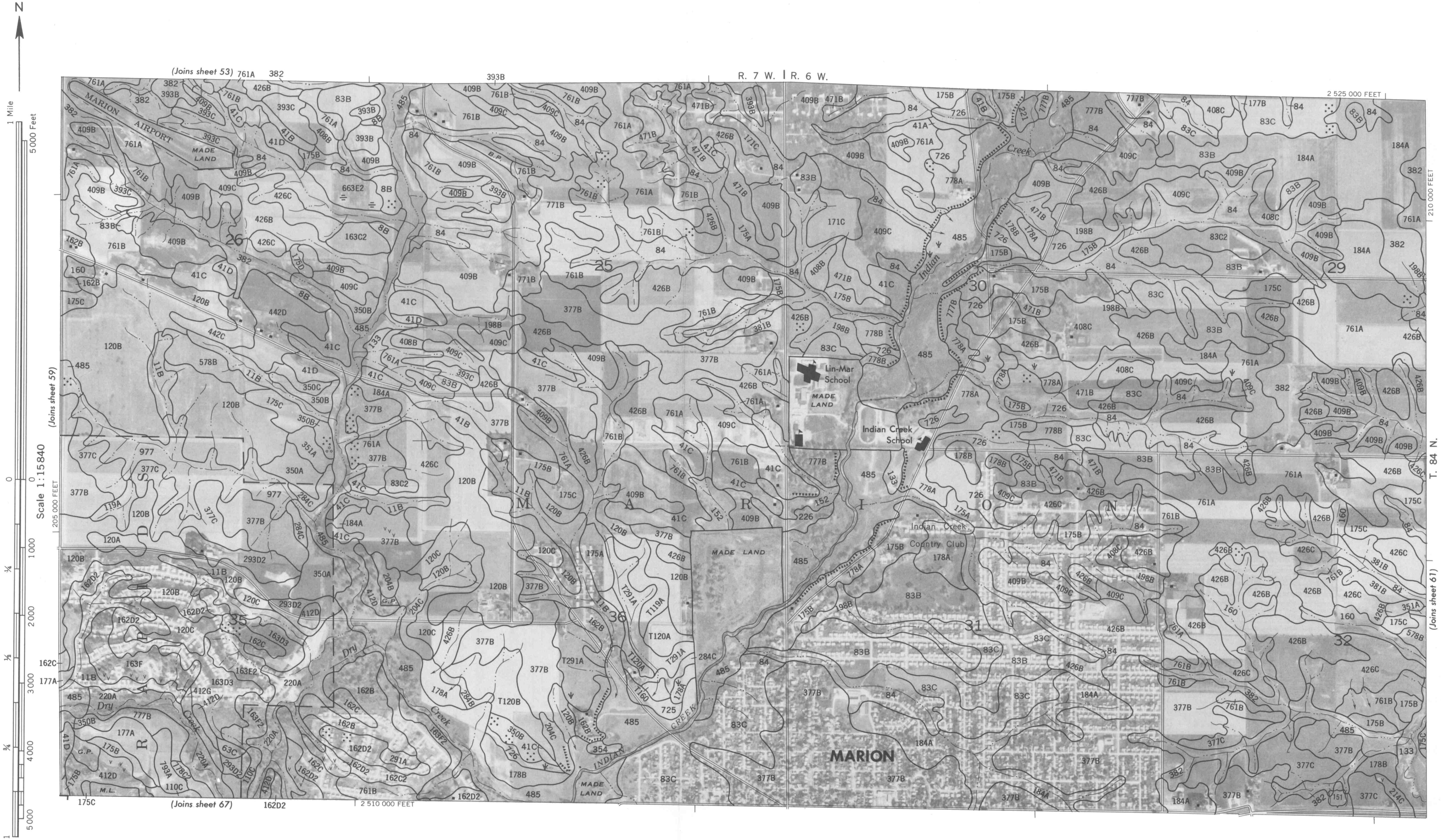

(Joins sheet 48)
(Joins sheet 54)
(Joins sheet 56)
(Joins sheet 62)
R. 6 W.
R. 5 W.
T. 84 N.
2 550 000 FEET
2 565 000 FEET
220 000 FEET
215 000 FEET
Whittier
Springville
Big Creek
GRAVEL PIT
BROWN
MARION
N
1 Mile
5000 Feet
Scale 1:15 840

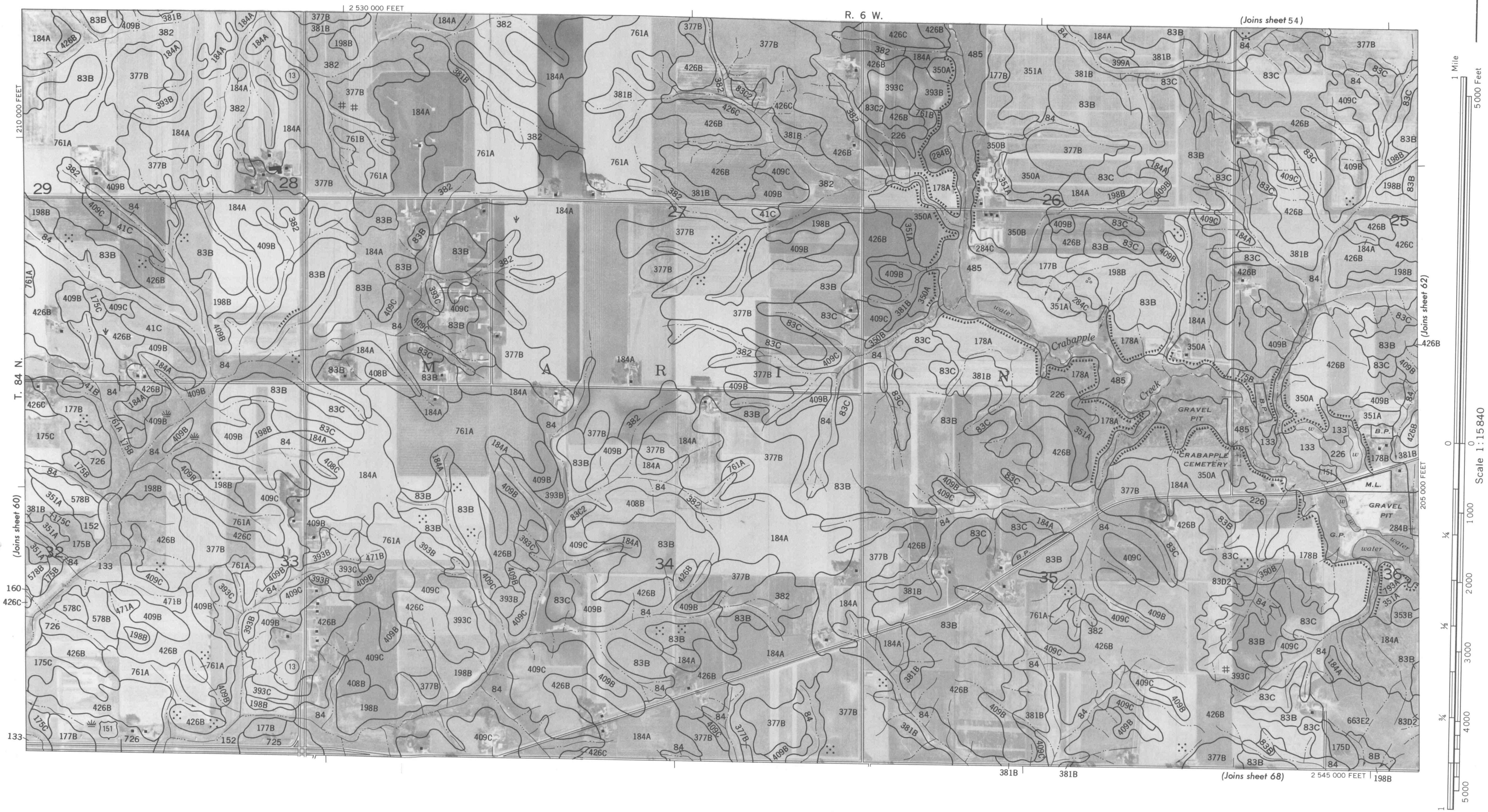

N
1 Mile
5 000 Feet
Scale 1:15840
(Joins sheet 49)
R. 5 W.
Viola
2 580 000 FEET
220 000 FEET
(Joins sheet 55)
215 000 FEET
T. 84 N.
JONES COUNTY
(Joins sheet 63)
2 570 000 FEET
Crows Creek
East Big Creek
MILWAUKEE AND ST. PAUL PACIFIC
CHICAGO
B R O W N
14
13
15
22
23
24

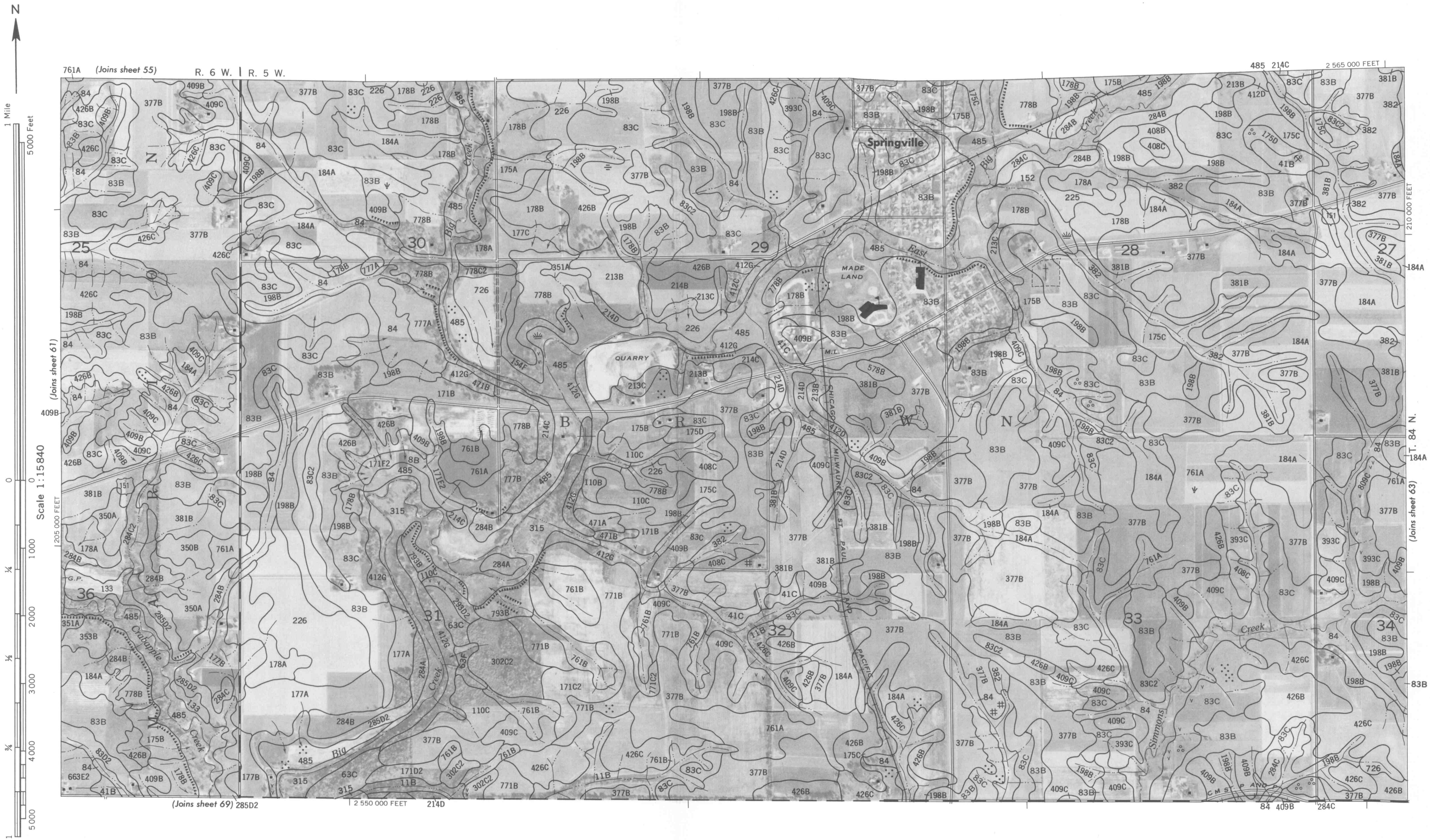

N
R. 8 W.
T. 84 N.
2 450 000 FEET
210 000 FEET
205 000 FEET
2 465 000 FEET
(Joins sheet 50)
(Joins sheet 58)
(Joins sheet 64)
BENTON COUNTY
LINN COUNTY, IOWA NO. 57
Palo
PALO CEMETERY
CHICAGO ROCK ISLAND AND PACIFIC
Dry Creek
Lime Creek
QUARRY
F A Y E T T E
29
30
31
32
33
28
Scale 1:15 840
1 Mile
5000 Feet


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 51)
(Joins sheet 57)
(Joins sheet 59)
(Joins sheet 65)
R. 8 W.
R. 7 W.
T. 84 N.
2 485 000 FEET
210 000 FEET
205 000 FEET
2 470 000 FEET
Mud Lake
GRAVEL PIT
Campsite
Chain Lakes County Park
CEDAR RIVER
Otter Creek
MONROE
FAYETTE
MORRISON CEMETERY
CHICAGO ROCK ISLAND AND PACIFIC


N
(Joins sheet 52)
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 66)
R. 7 W.
T. 84 N.
2 490 000 FEET
2 505 000 FEET
210 000 FEET
205 000 FEET
M O N R O E
M A R I O N
R A P I D S
MONROE
MARION
Hiawatha
Trailer Park
MADE LAND
S.L.
G.P.
Dry Creek
WATERLOO
CENTRAL
ILLINOIS
29
28
27
30
31
32
33
34
Scale 1:15 840
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1

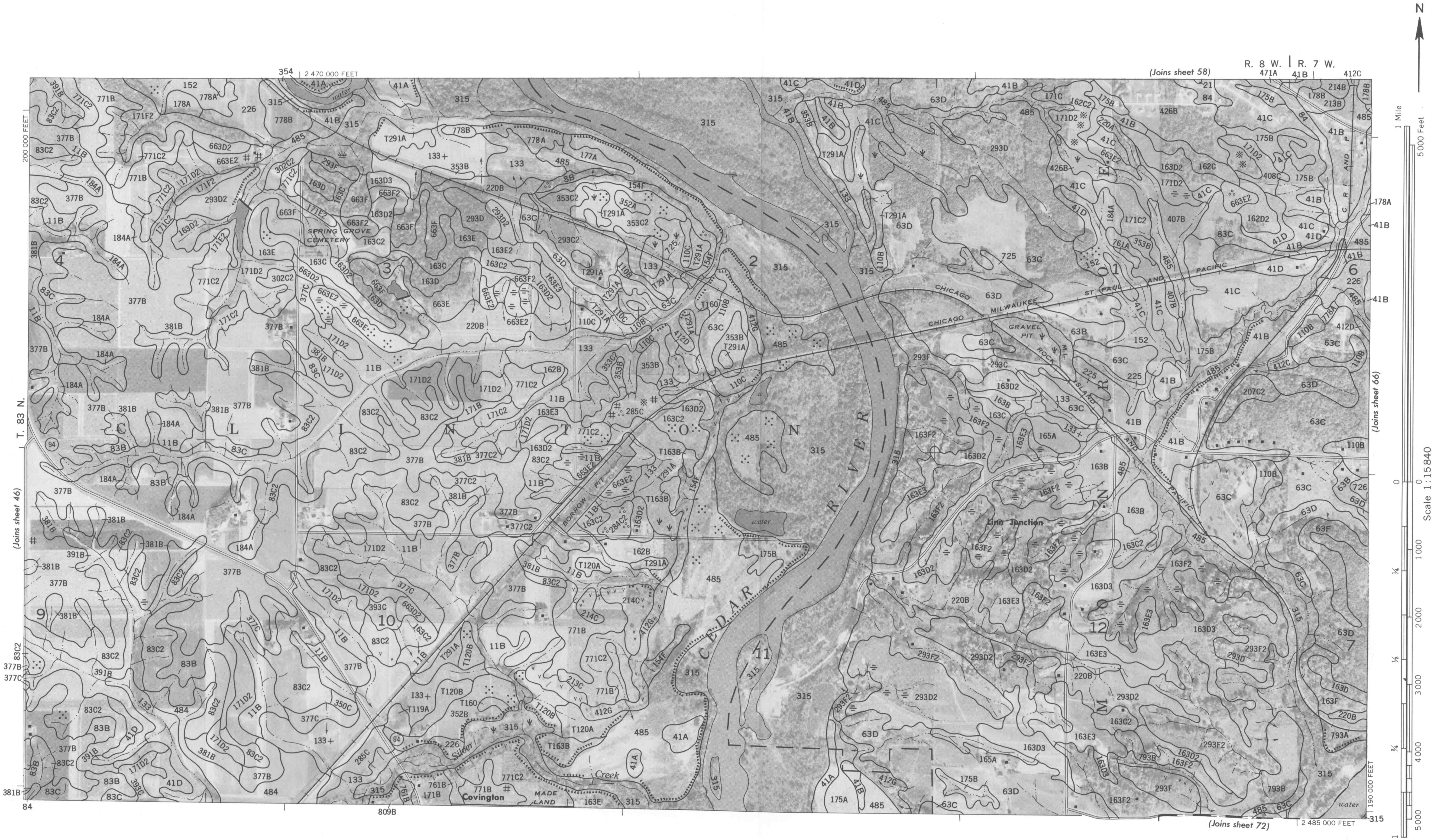

N
1 Mile
5 000 Feet
Scale 1:15840
(Joins sheet 53)
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 67)
R. 7 W. | R. 6 W.
T. 84 N.
2 525 000 FEET
210 000 FEET
205 000 FEET
2 510 000 FEET
MARION AIRPORT
MADE LAND
Lin-Mar School
Indian Creek School
Indian Creek Country Club
Indian Creek
Dry Creek
MARION
26
25
30
29
35
36
31
32

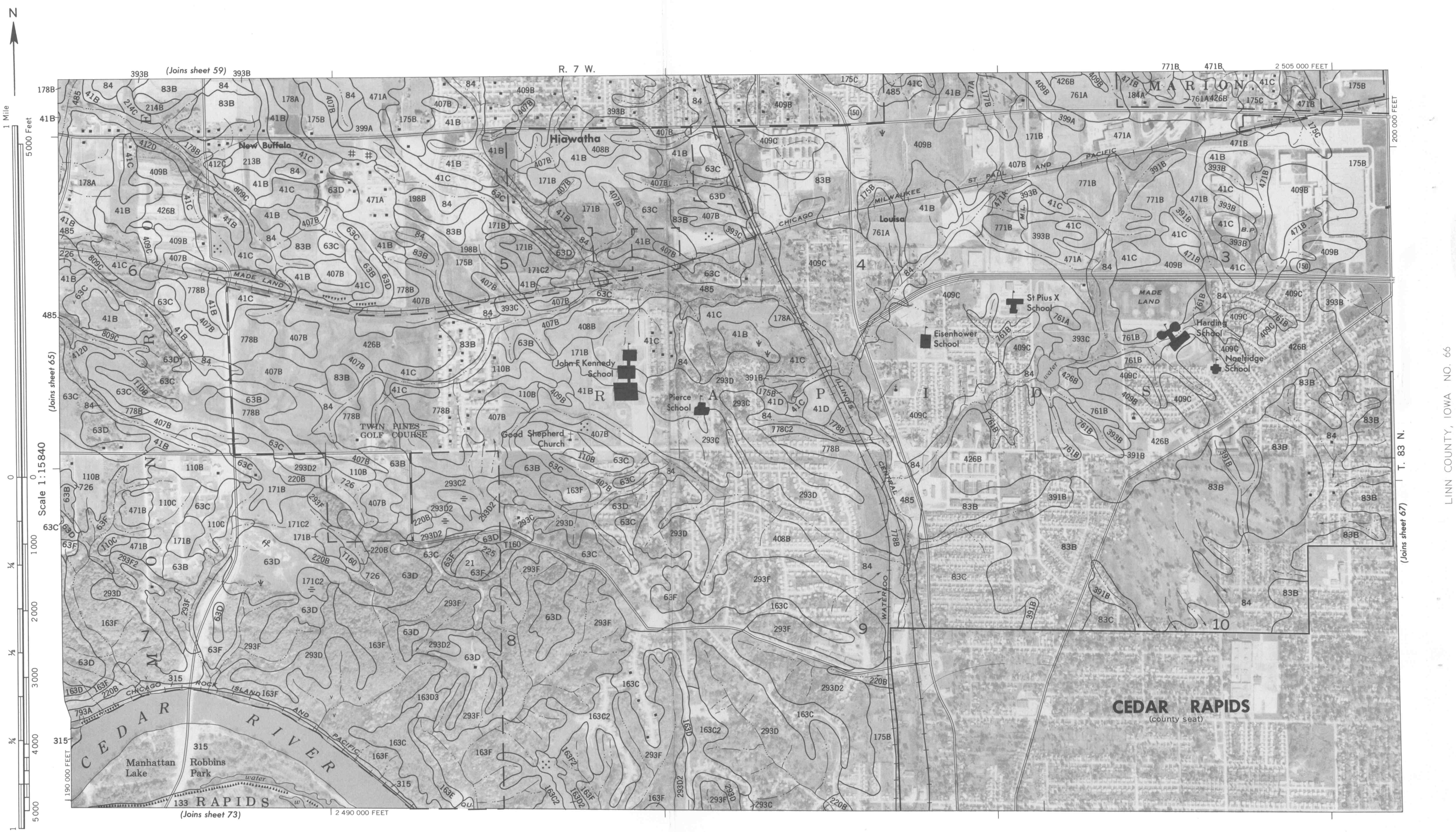

N
R. 6 W.
T. 84 N.
2 530 000 FEET
2 545 000 FEET
210 000 FEET
205 000 FEET
(Joins sheet 54)
(Joins sheet 62)
(Joins sheet 68)
(Joins sheet 60)
M A R I O N
Crabapple Creek
CRABAPPLE CEMETERY
GRAVEL PIT
water
29
28
27
26
25
32
33
34
35
36
Scale 1:15840
1 Mile
5000 Feet

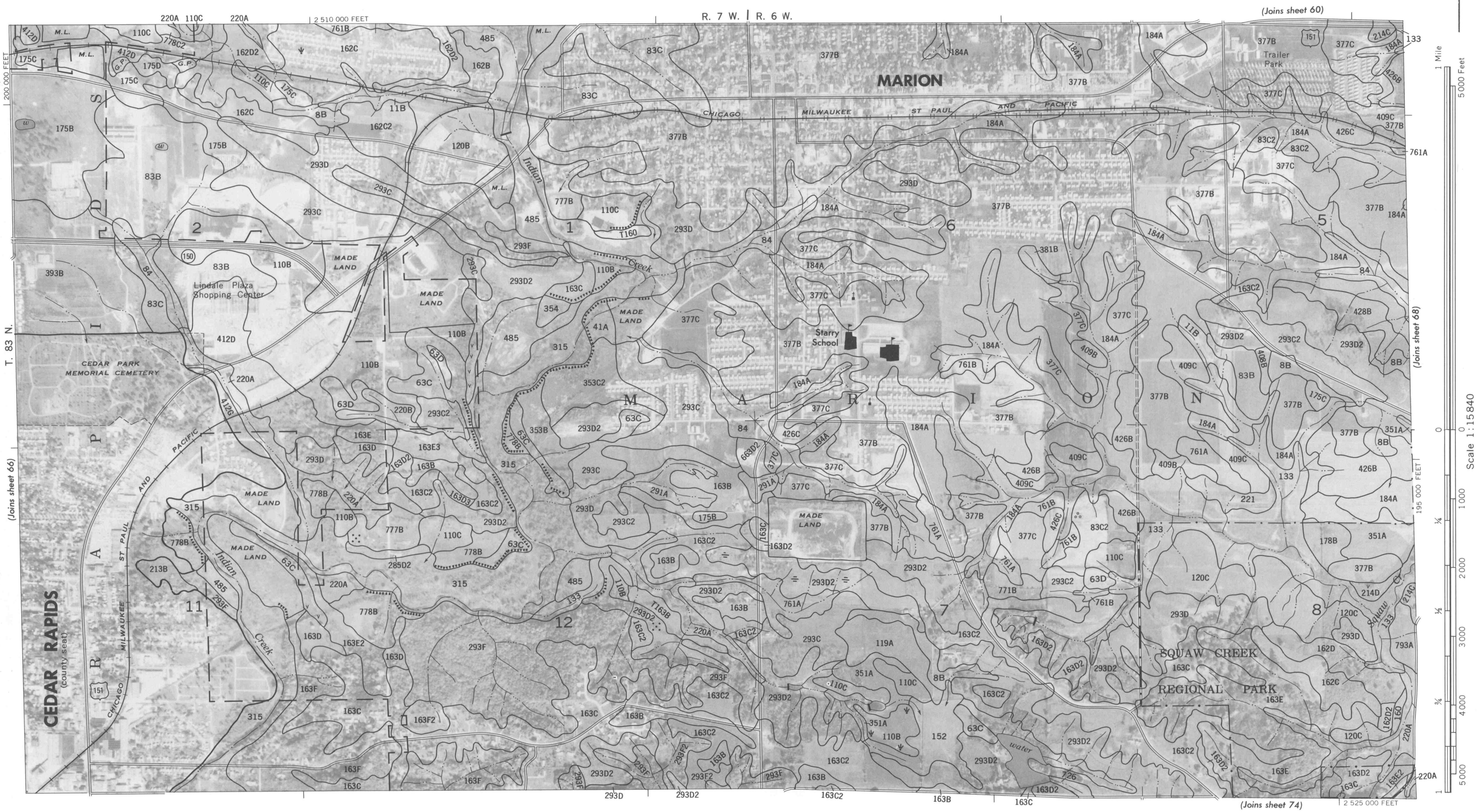

N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 55)
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 69)
R. 6 W.
R. 5 W.
T. 84 N.
2 565 000 FEET
2 550 000 FEET
210 000 FEET
205 000 FEET
Springville
QUARRY
MADE LAND
G.P.
BROWN
MARION
Big Creek
East Big Creek
Crabapple Creek
Simmons Creek
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
C M ST P AND P
25
30
29
28
27
36
31
32
33
34

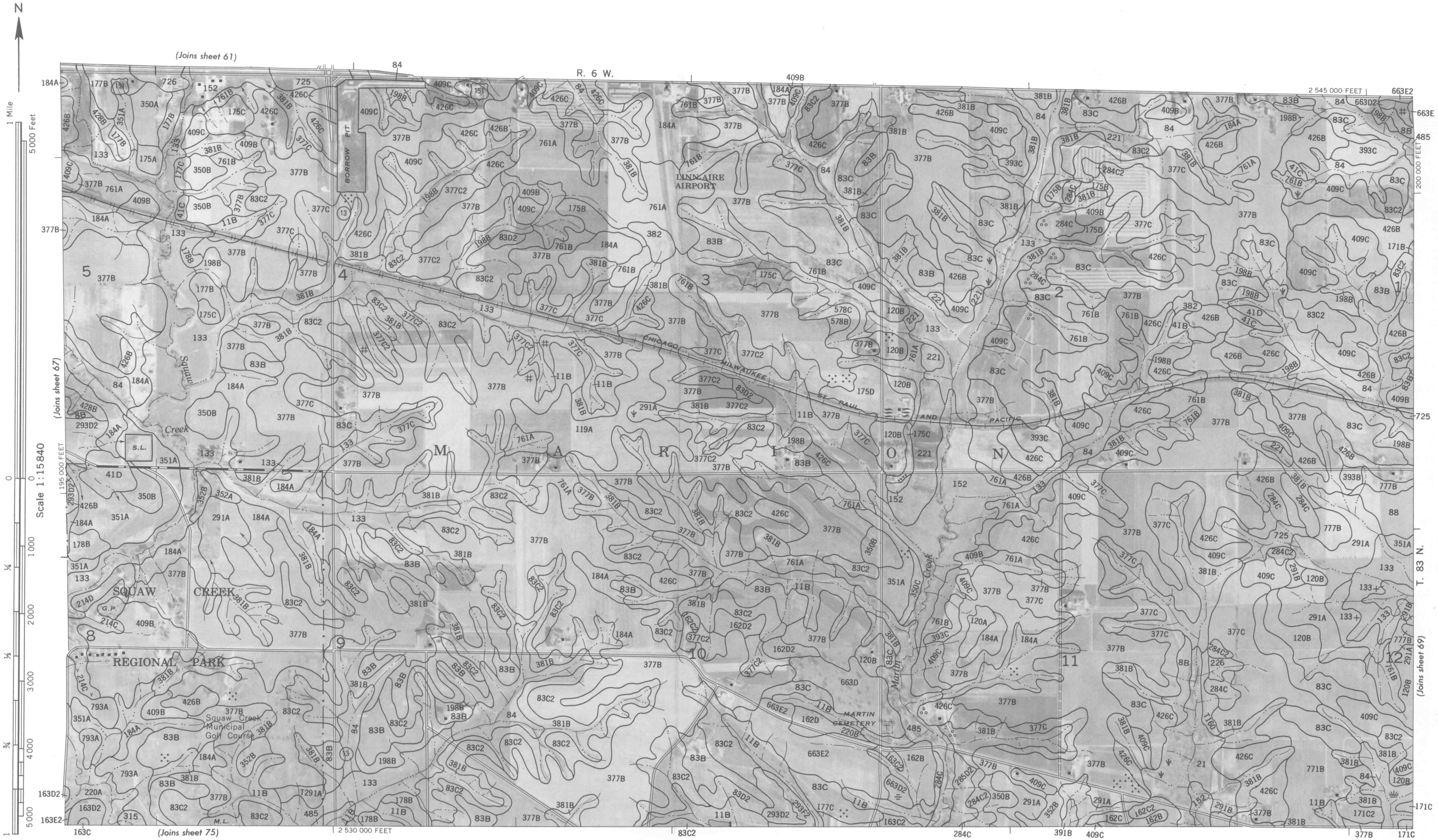

N
2 570 000 FEET
R. 5 W.
(Joins sheet 56)
210 000 FEET
T. 84 N.
(Joins sheet 62)
27
26
25
34
35
36
B R O W N
Big Creek
East
Simmons Creek
G.P.
JONES COUNTY
205 000 FEET
2 585 000 FEET
(Joins sheet 70)
1 Mile
5000 Feet
Scale 1:15840
0
¼
½
¾
1
0
1000
2000
3000
4000
5000


N
1 Mile
5000 Feet
Scale 1:15840
R 8 W.
(Joins sheet 57)
(Joins sheet 71)
(Joins sheet 65)
T. 83 N.
BENTON COUNTY
CLINTON
Lone Tree Creek
Lincoln Church
2 465 000 FEET
2 450 000 FEET
200 000 FEET
190 000 FEET

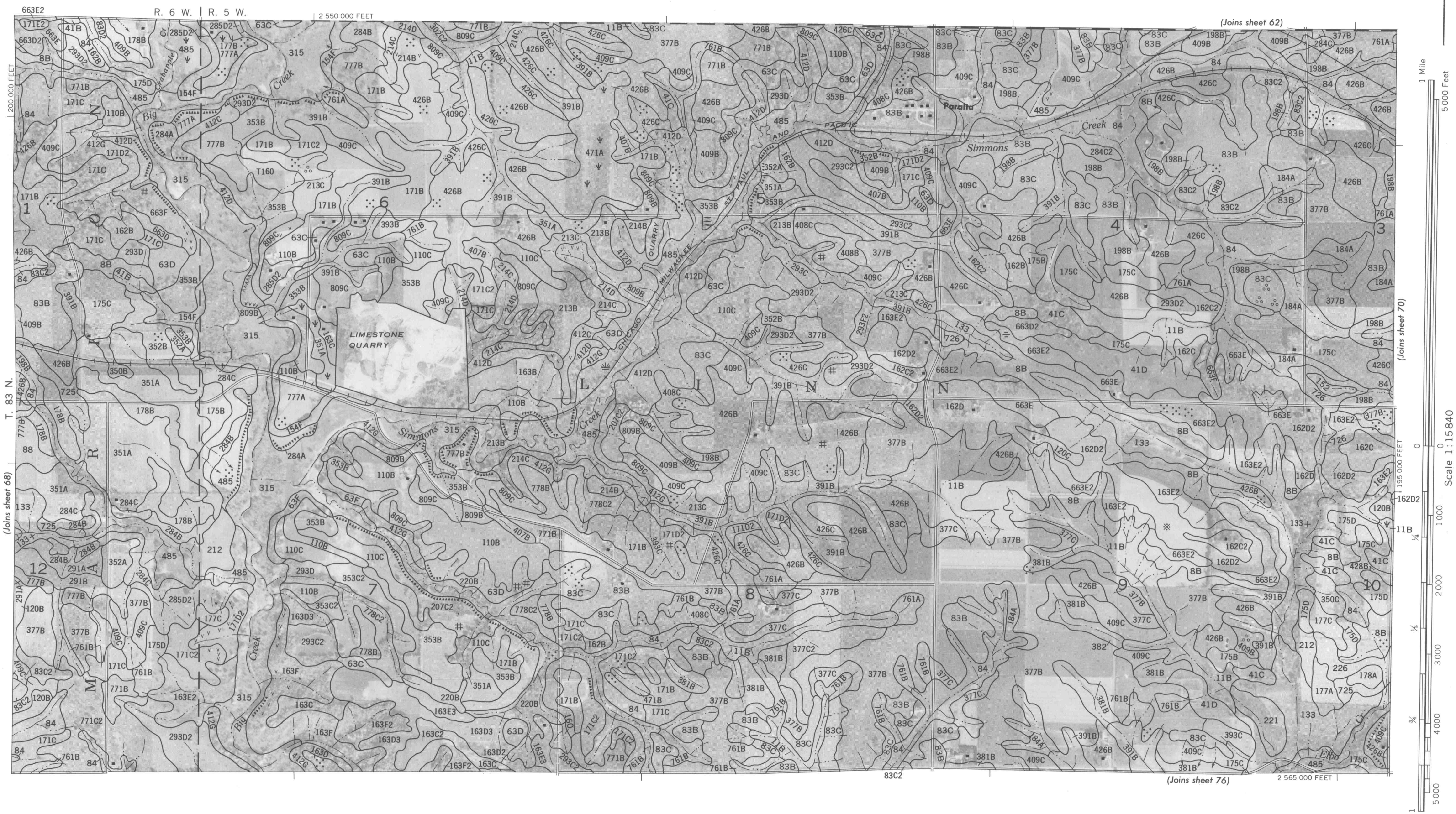

N
R. 8 W. | R. 7 W.
(Joins sheet 58)
(Joins sheet 46)
(Joins sheet 66)
(Joins sheet 72)
T. 83 N.
2 470 000 FEET
2 485 000 FEET
200 000 FEET
190 000 FEET
CLINTON
FAIRFAX (partial lettering: F O R)
CEDAR RIVER
SPRING GROVE CEMETERY
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
CHICAGO ROCK ISLAND AND PACIFIC
GRAVEL PIT
BORROW PIT
Linn Junction
Covington
Silver Creek
MADE LAND
water
Scale 1:15840
1 Mile
5000 Feet


N
1 Mile
5000 Feet
Scale 1:15 840
(Joins sheet 59)
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 73)
R. 7 W.
T. 83 N.
2 505 000 FEET
200 000 FEET
190 000 FEET
2 490 000 FEET
Hiawatha
New Buffalo
MARION
Louisa
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
CHICAGO ROCK ISLAND AND PACIFIC
ILLINOIS CENTRAL
WATERLOO
MADE LAND
TWIN PINES GOLF COURSE
Good Shepherd Church
John F Kennedy School
Pierce School
Eisenhower School
St Pius X School
Harding School
Noelridge School
CEDAR RAPIDS
(county seat)
CEDAR RIVER
Manhattan Lake
Robbins Park
water
LINN COUNTY, IOWA NO. 66

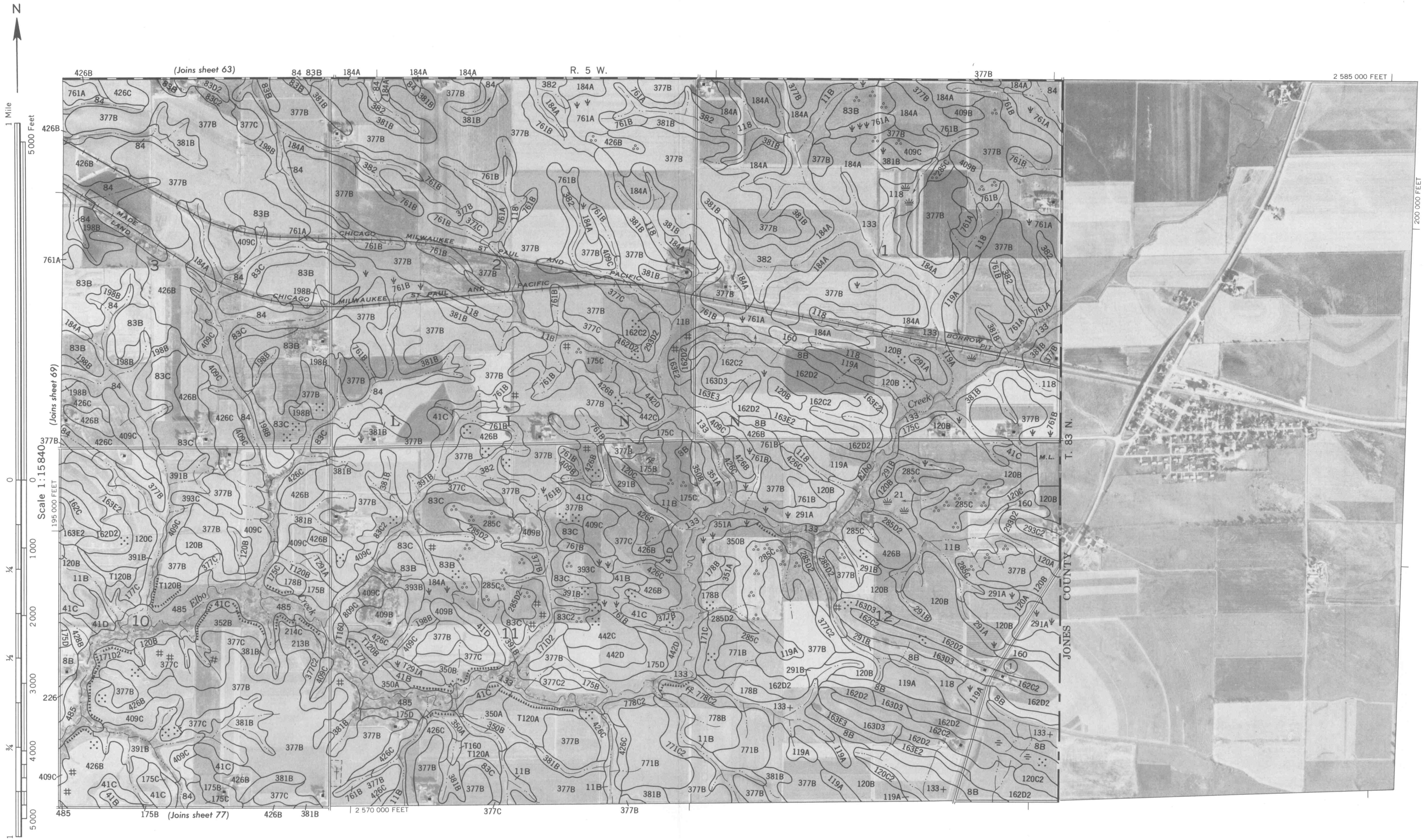

N
(Joins sheet 60)
R. 7 W. | R. 6 W.
2 510 000 FEET
200 000 FEET
MARION
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
Lindale Plaza Shopping Center
CEDAR PARK MEMORIAL CEMETERY
Starry School
MADE LAND
Indian Creek
T. 83 N.
(Joins sheet 66)
(Joins sheet 68)
(Joins sheet 74)
CEDAR RAPIDS (county seat)
SQUAW CREEK REGIONAL PARK
Squaw Cr.
Trailer Park
195 000 FEET
2 525 000 FEET
1 Mile
5000 Feet
Scale 1:15840
LINN COUNTY, IOWA NO. 67



LINN COUNTY, IOWA NO. 68

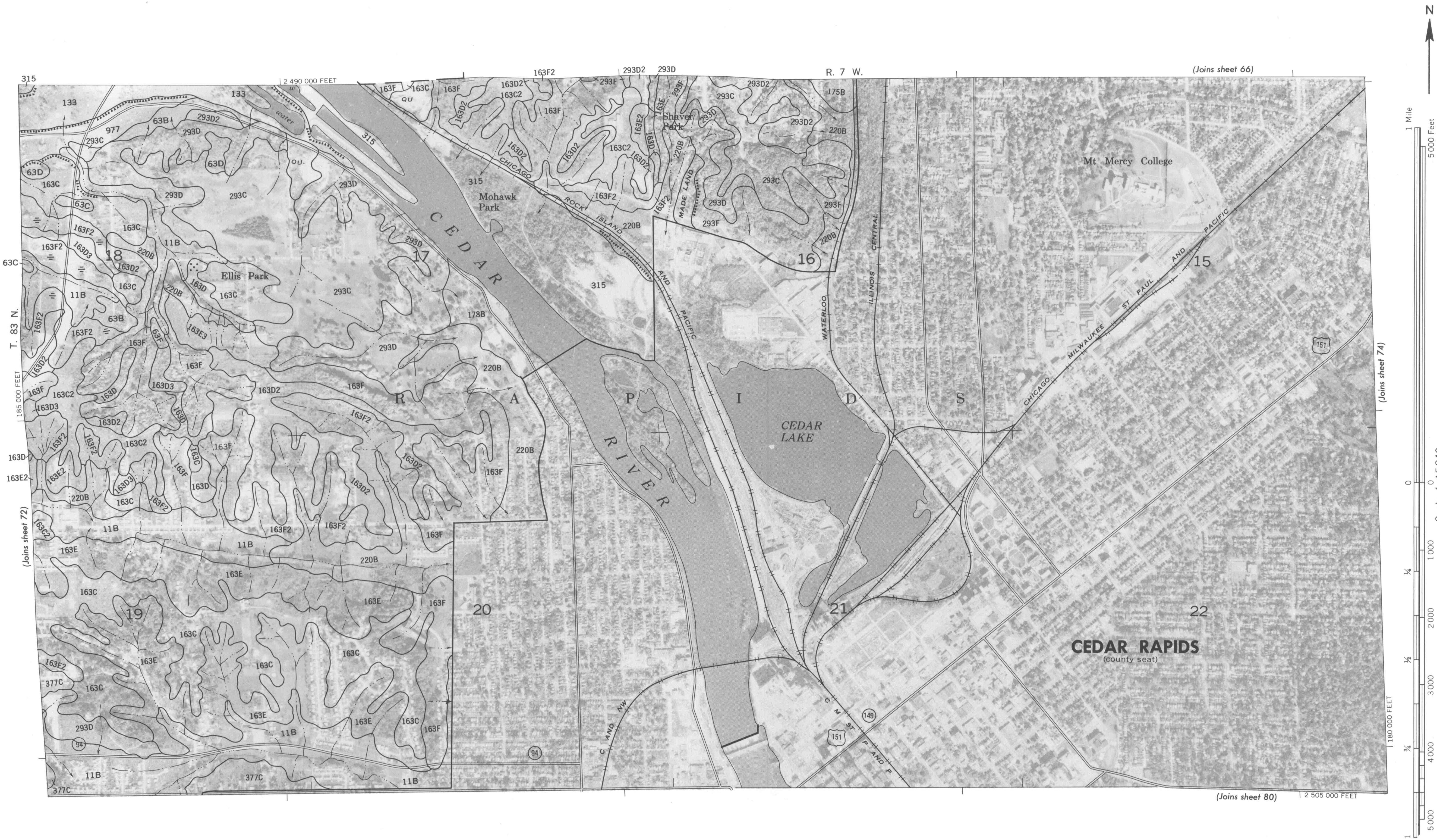


LINN COUNTY, IOWA NO. 69

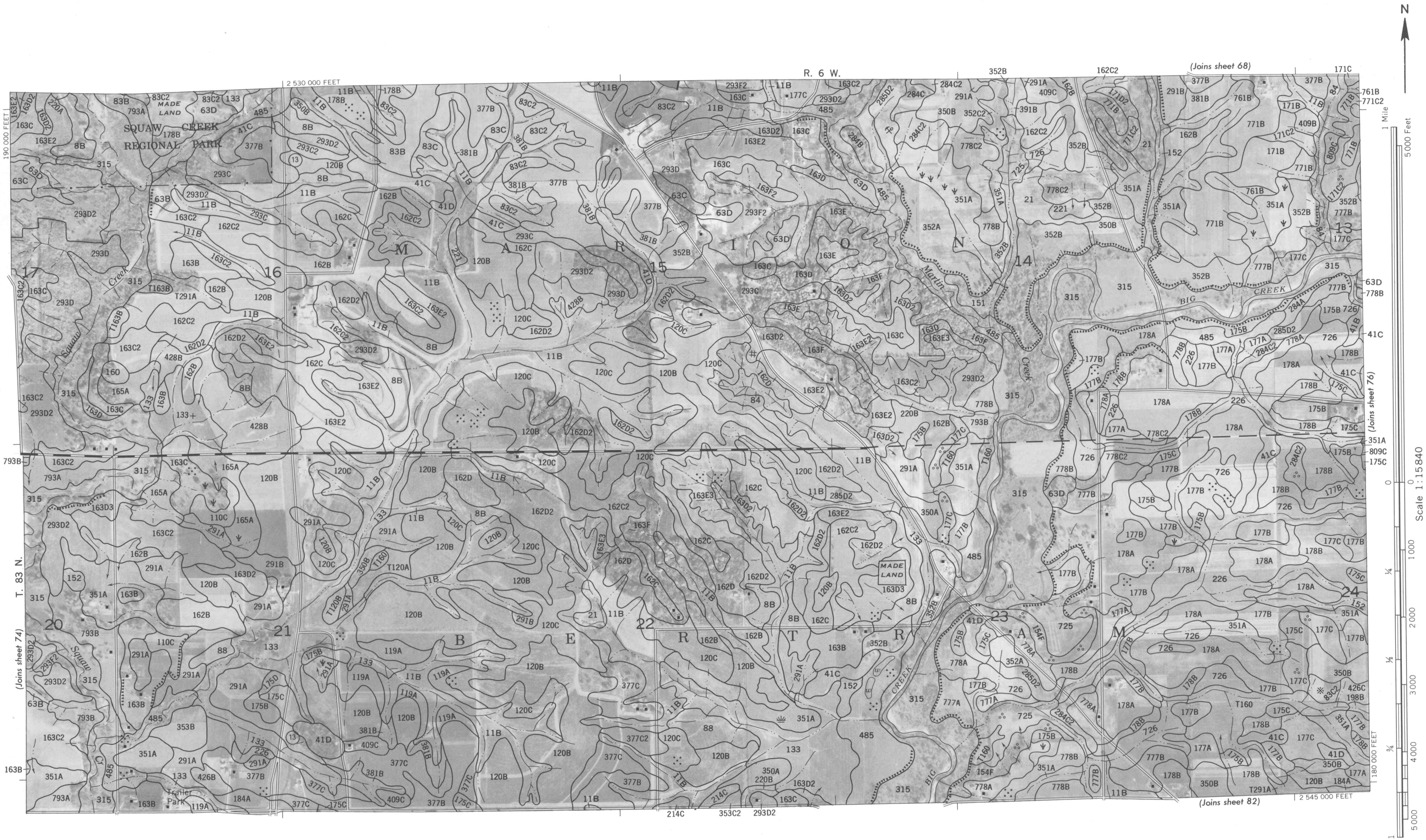

N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 63)
(Joins sheet 69)
(Joins sheet 77)
R. 5 W.
T. 83 N.
2 585 000 FEET
200 000 FEET
195 000 FEET
2 570 000 FEET
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
MADE LAND
BORROW PIT
Elbo Creek
LINN
JONES COUNTY

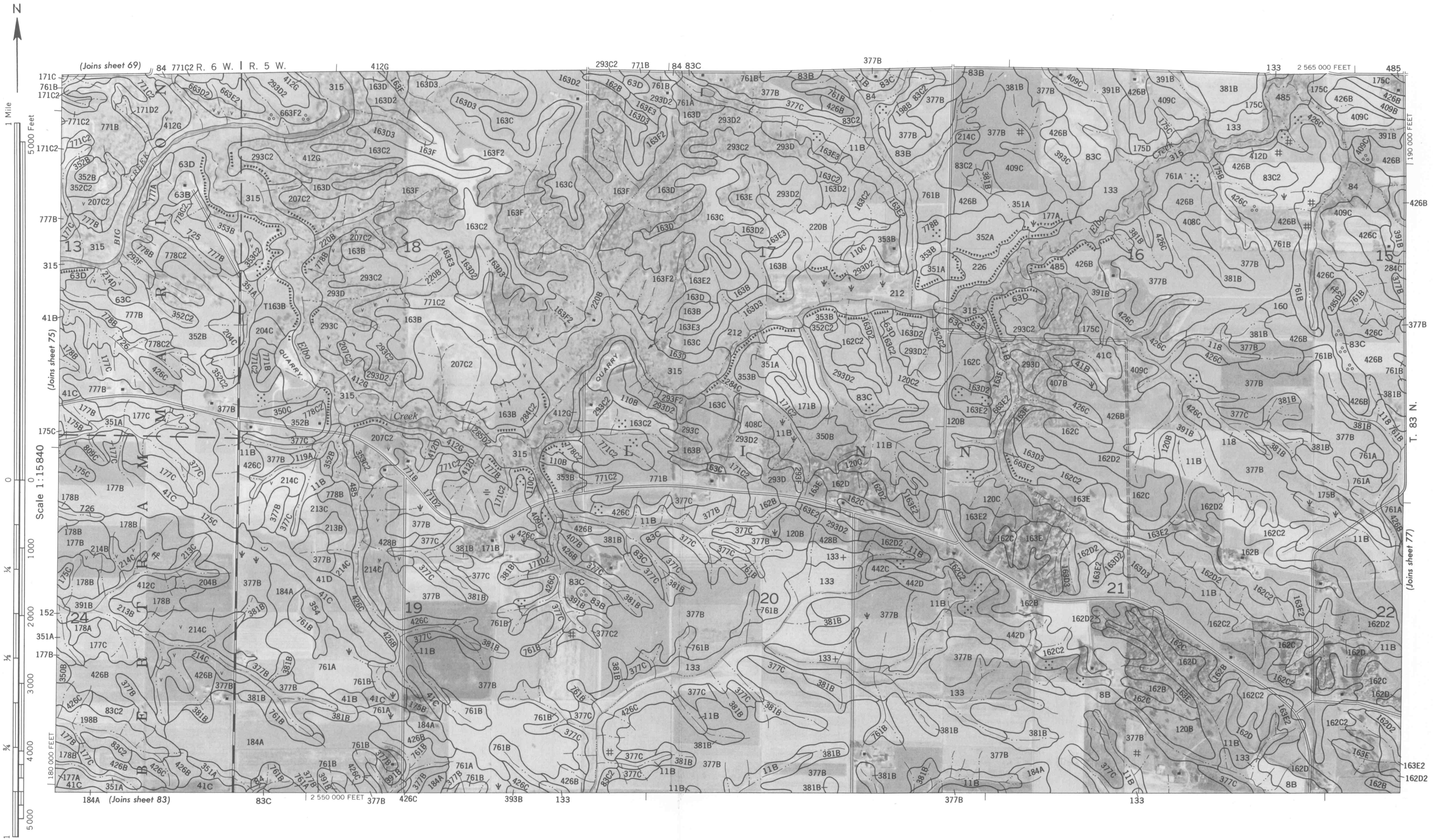

N
2 450 000 FEET
185 000 FEET
R. 8 W.
(Joins sheet 64)
(Joins sheet 72)
(Joins sheet 78)
T. 83 N.
BENTON COUNTY
C L I N T O N
Silver Creek
CHICAGO MILWAUKEE ST PAUL AND PACIFIC R.R.
16
17
18
19
20
21
180 000 FEET
2 465 000 FEET
1 Mile
5000 Feet
Scale 1:15840

LINN COUNTY, IOWA — SHEET NUMBER 72


N
R. 7 W.
(Joins sheet 66)
(Joins sheet 72)
(Joins sheet 74)
(Joins sheet 80)
T. 83 N.
2 490 000 FEET
2 505 000 FEET
185 000 FEET
180 000 FEET
CEDAR RAPIDS
(county seat)
CEDAR RIVER
CEDAR LAKE
Mt Mercy College
Mohawk Park
Ellis Park
Shaver Park
CHICAGO ROCK ISLAND AND PACIFIC
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
ILLINOIS CENTRAL
WATERLOO
C AND NW
C M ST P AND P
MADE LAND
15
16
17
18
19
20
21
22
Scale 1:15840
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
1 Mile
5000 Feet
Scale 1:15840
0
1000
2000
3000
4000
5000
¼
½
¾
1
R. 7 W. | R. 6 W.
(Joins sheet 67)
(Joins sheet 73)
(Joins sheet 75)
(Joins sheet 81)
2 525 000 FEET
190 000 FEET
180 000 FEET
2 510 000 FEET
T. 83 N.
Papoose Park
Indian Creek
Country Club
Washington School
Bever Park
SQUAW CREEK REGIONAL PARK
MADE LAND
BERTRAM
CEDAR RAPIDS
(county seat)
Vernon View
S D I P A R
M A R I O N
B E R T R A M
151
13
14
17
18
19
20
23
24


N
R. 6 W.
T. 83 N.
(Joins sheet 68)
(Joins sheet 76)
(Joins sheet 82)
(Joins sheet 74)
2 530 000 FEET
2 545 000 FEET
190 000 FEET
180 000 FEET
SQUAW CREEK REGIONAL PARK
MADE LAND
Squaw Creek
Martin Creek
BIG CREEK
Trailer Park
MARION
BERTRAM
13
14
15
16
17
20
21
22
23
24
Scale 1:15 840
1 Mile
5 000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
(Joins sheet 69)
R. 6 W.
R. 5 W.
2 565 000 FEET
190 000 FEET
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 83)
2 550 000 FEET
180 000 FEET
T. 83 N.
Scale 1:15 840
1 Mile
5000 Feet
BIG CREEK
Elbo Creek
QUARRY
BERTRAM
LINN
13
15
16
17
18
19
20
21
22
24

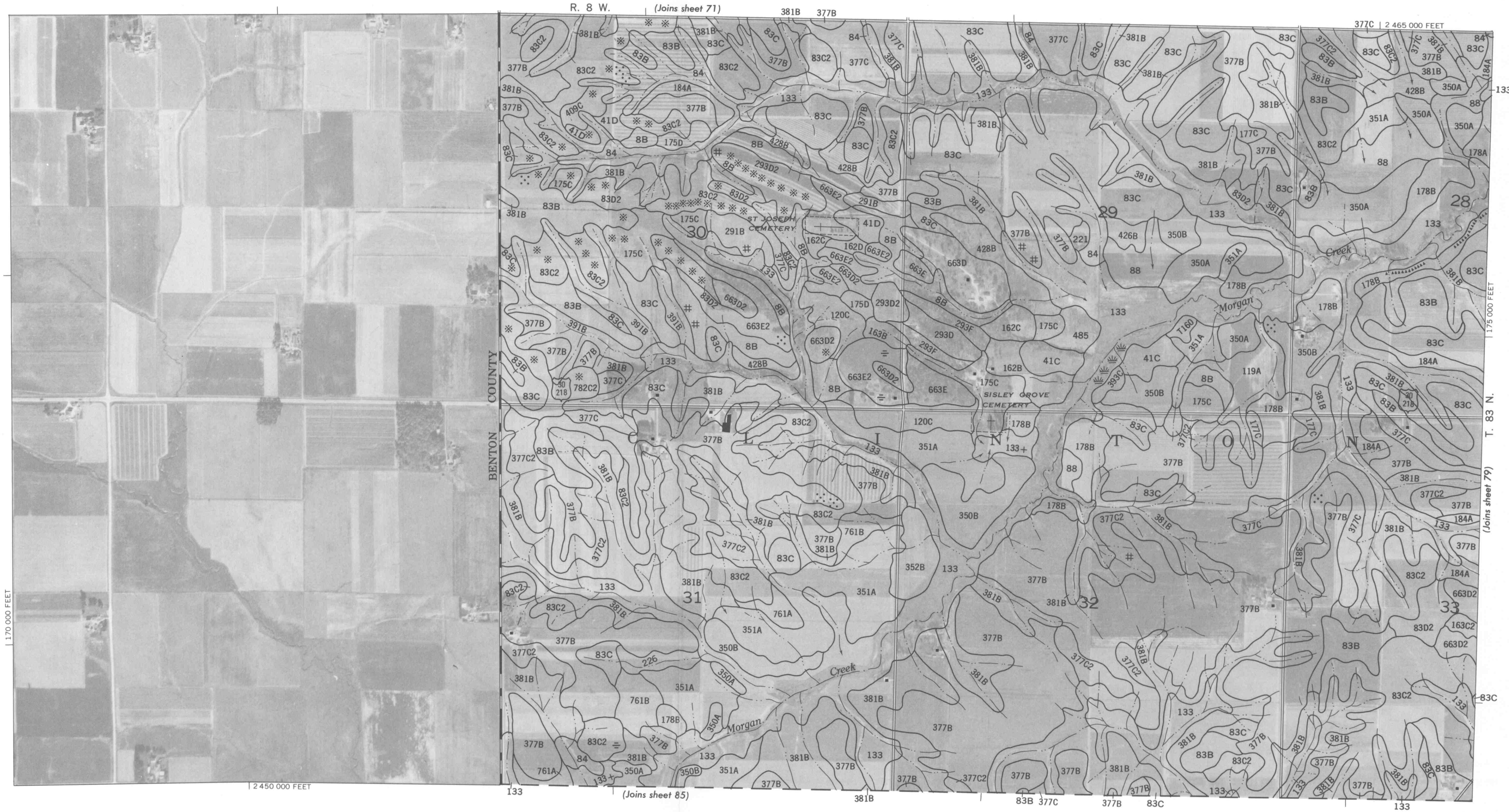

2 570 000 FEET
R. 5 W.
(Joins sheet 70)
190 000 FEET
T. 83 N.
(Joins sheet 76)
(Joins sheet 84)
2 585 000 FEET
185 000 FEET
LINN
JONES COUNTY
TONNE LANDING STRIP
15
14
13
22
23
24
N
1 Mile
5000 Feet
Scale 1:15 840

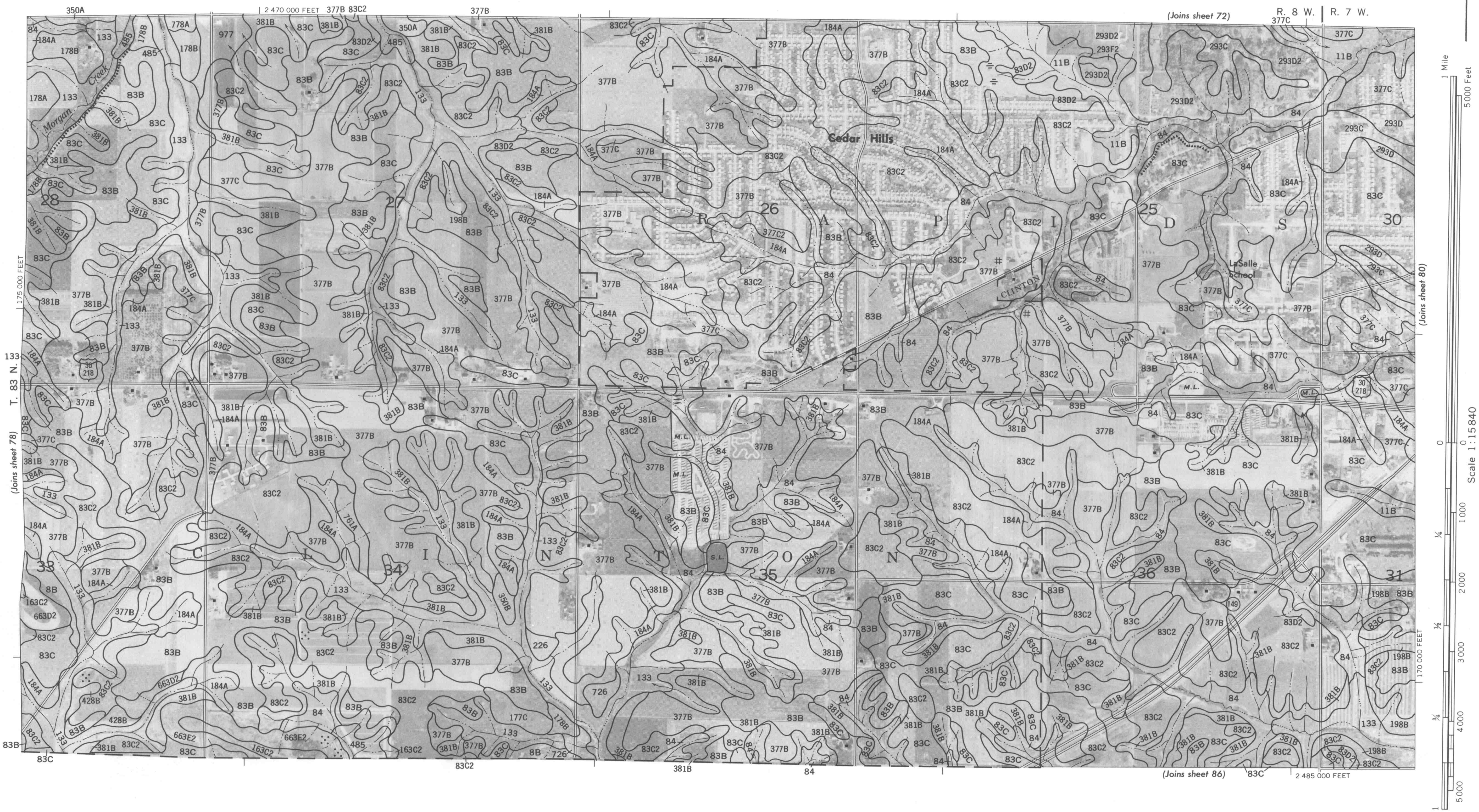
N

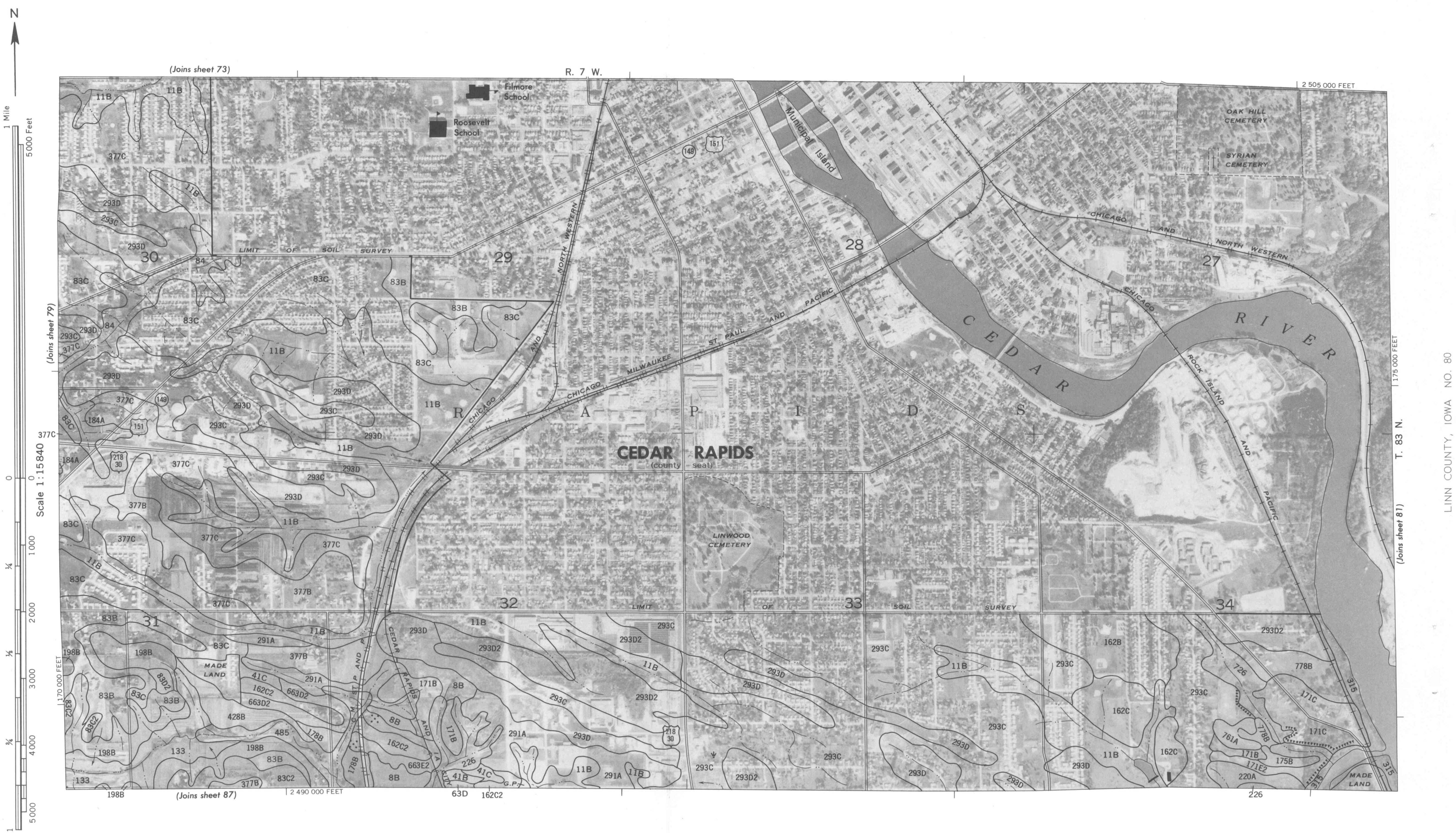
1 Mile

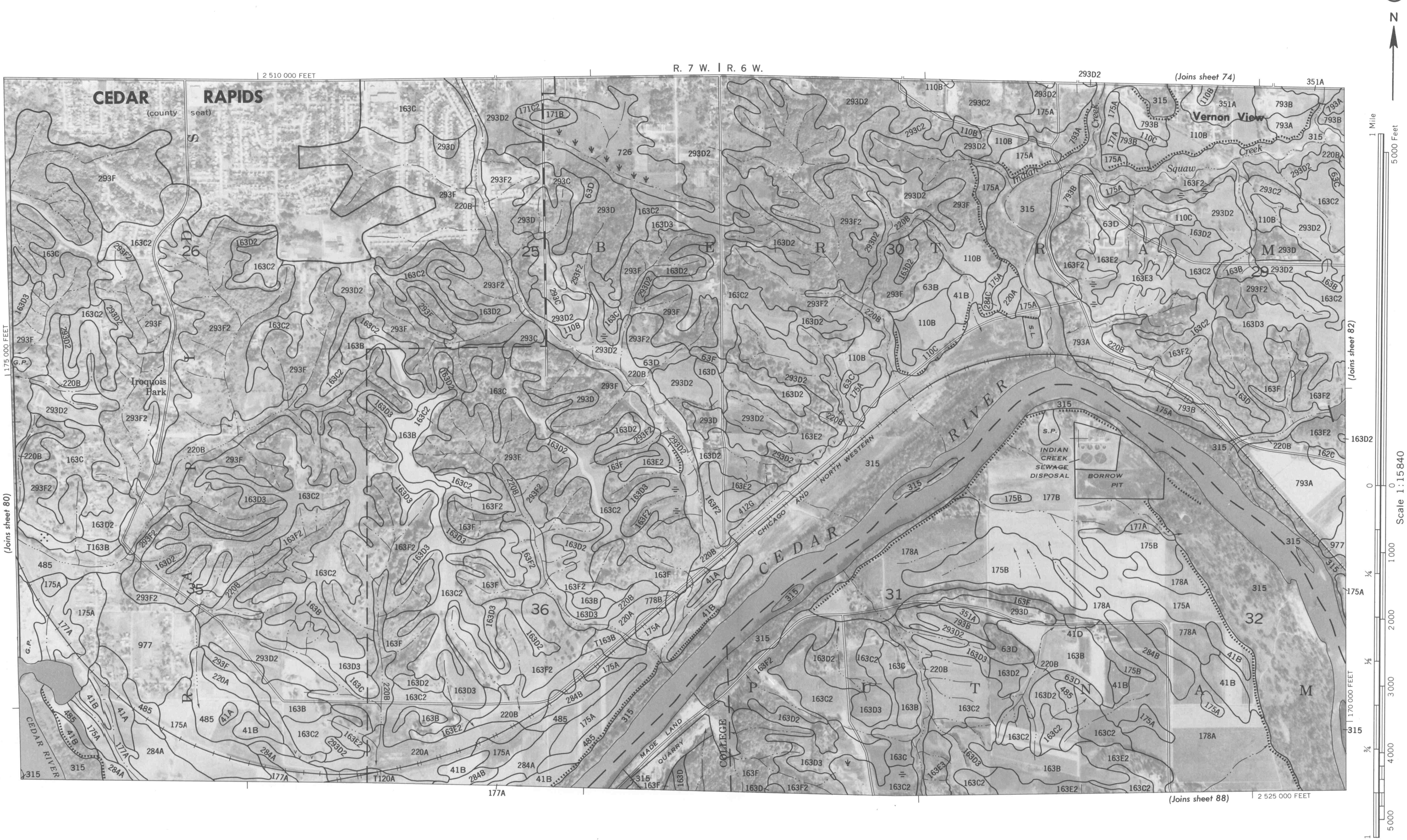
5 000 Feet

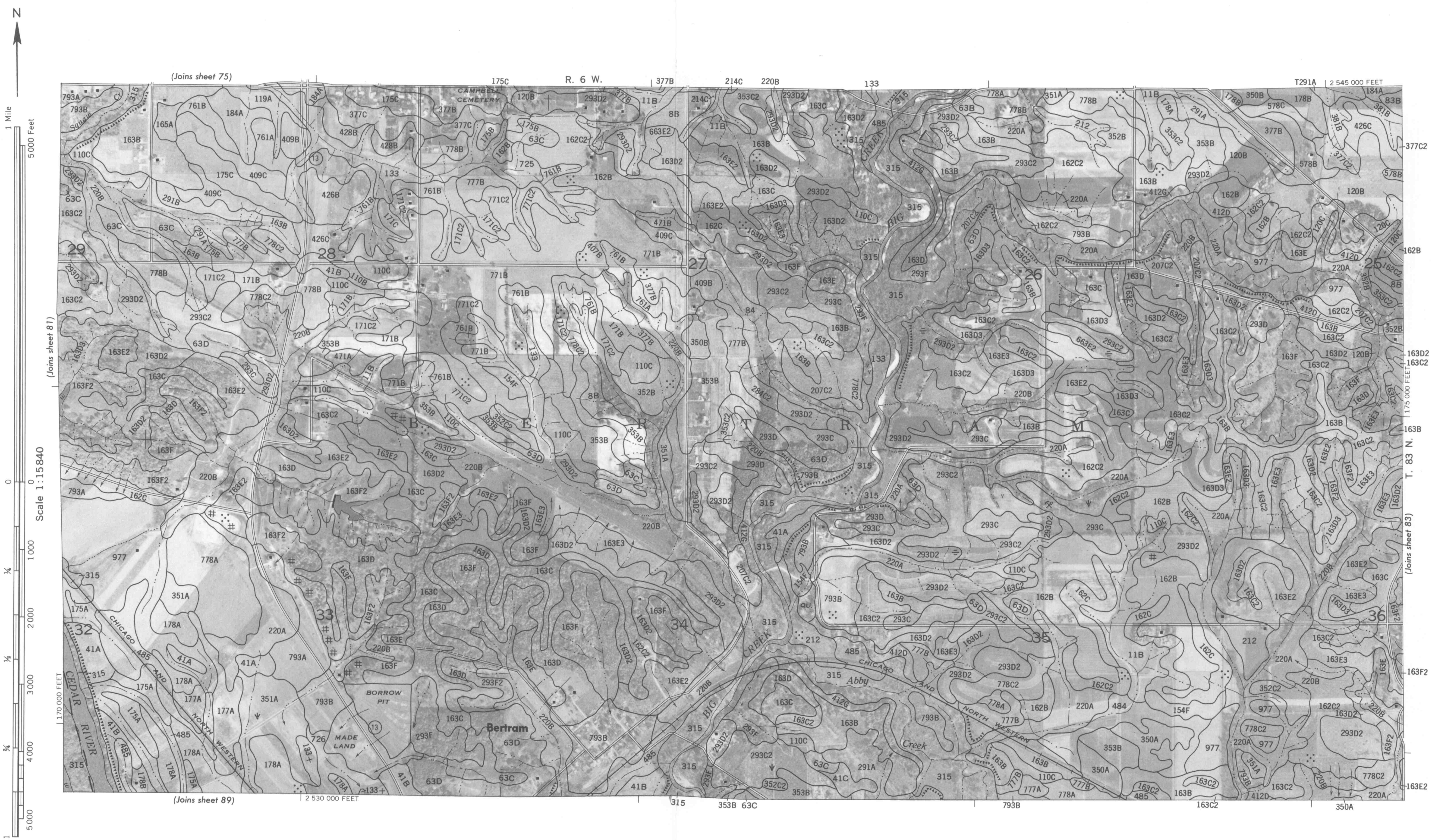
Scale 1:15840

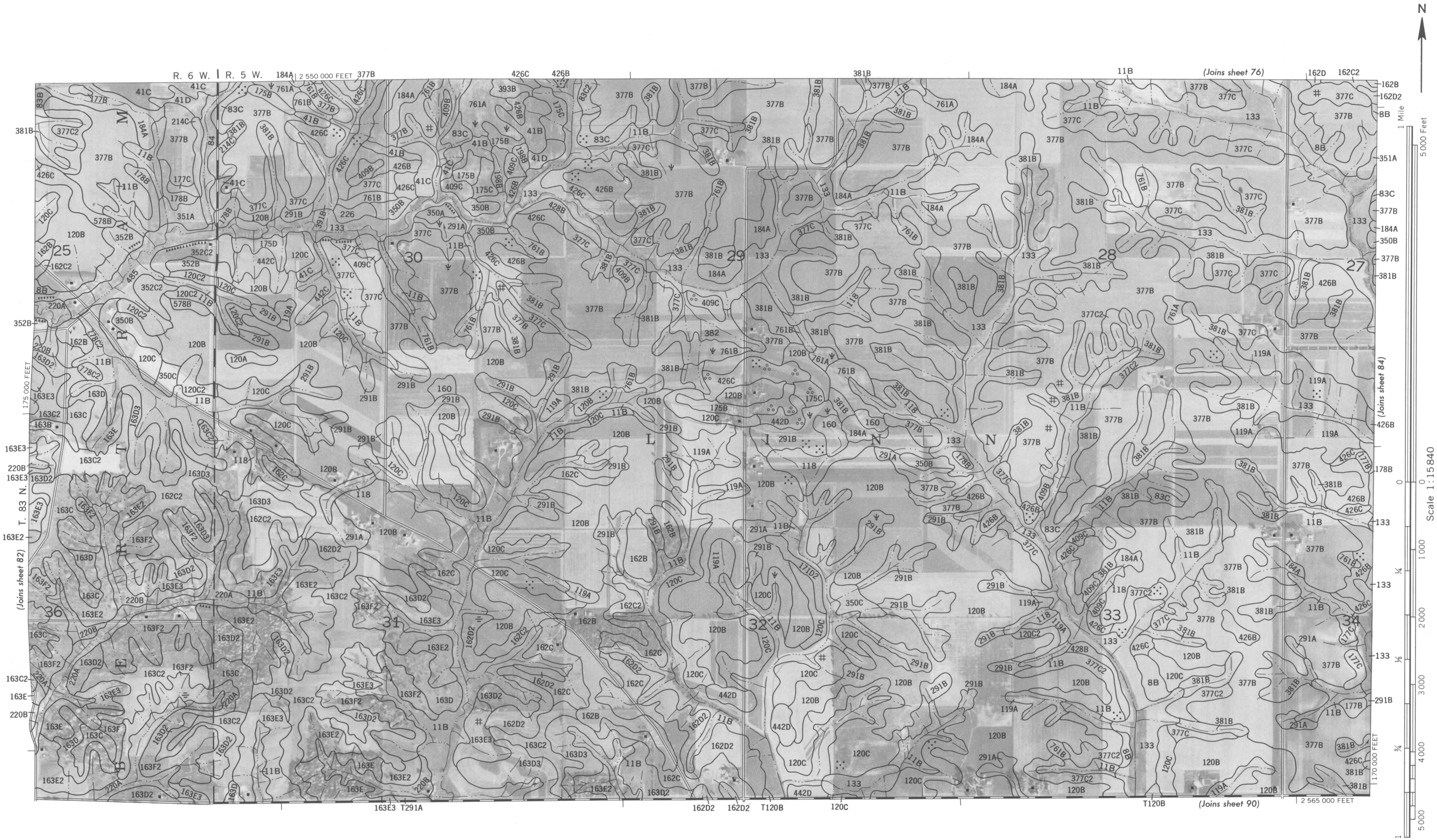


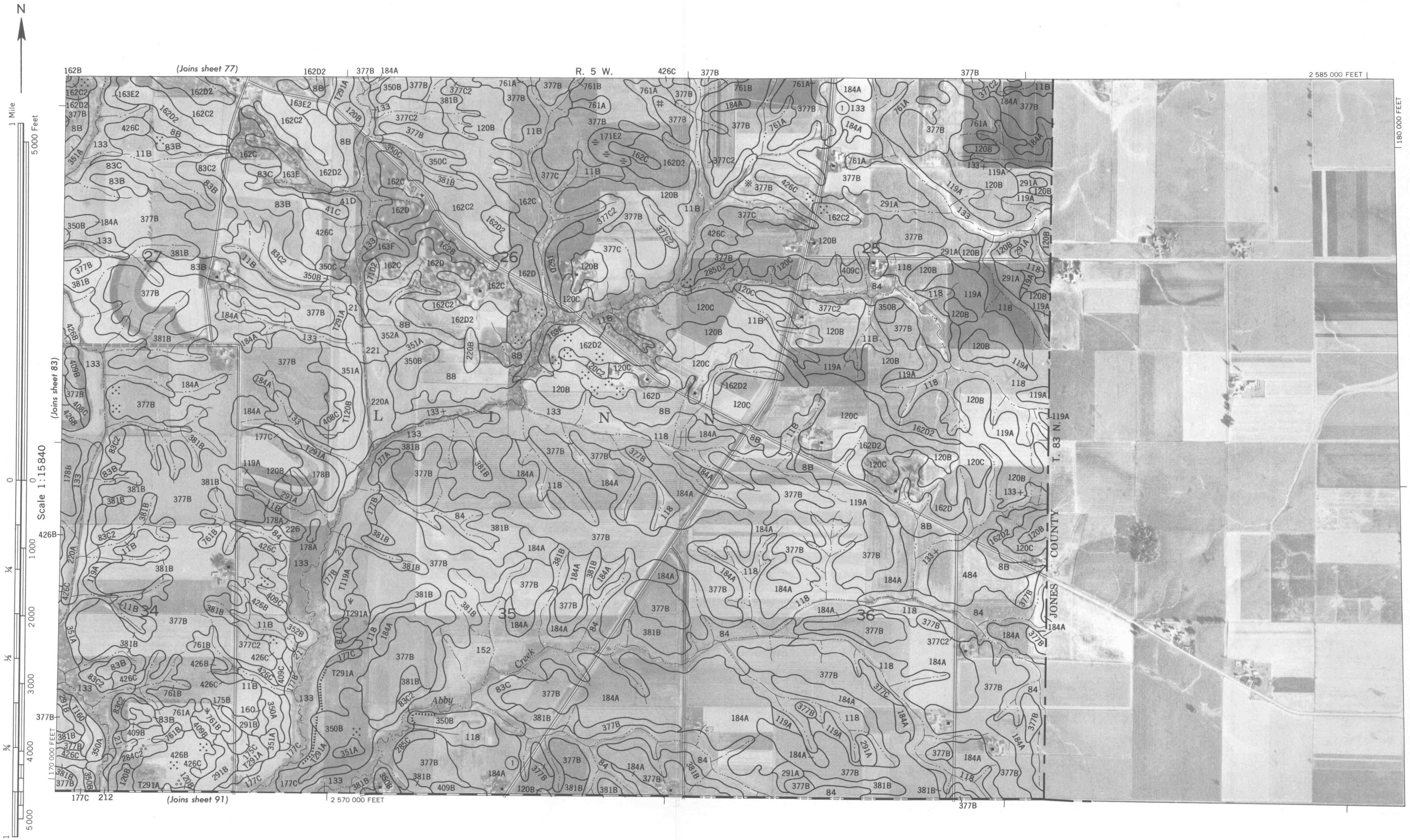

N
(Joins sheet 72)
R. 8 W.
R. 7 W.
2 470 000 FEET
(Joins sheet 78)
(Joins sheet 80)
(Joins sheet 86)
2 485 000 FEET
175 000 FEET
170 000 FEET
T. 83 N.
Cedar Hills
CLINTON
LaSalle School
Morgan Creek
C L I N T O N
R A P I D S
28
27
26
25
30
33
34
35
36
31
1 Mile
5000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾
1

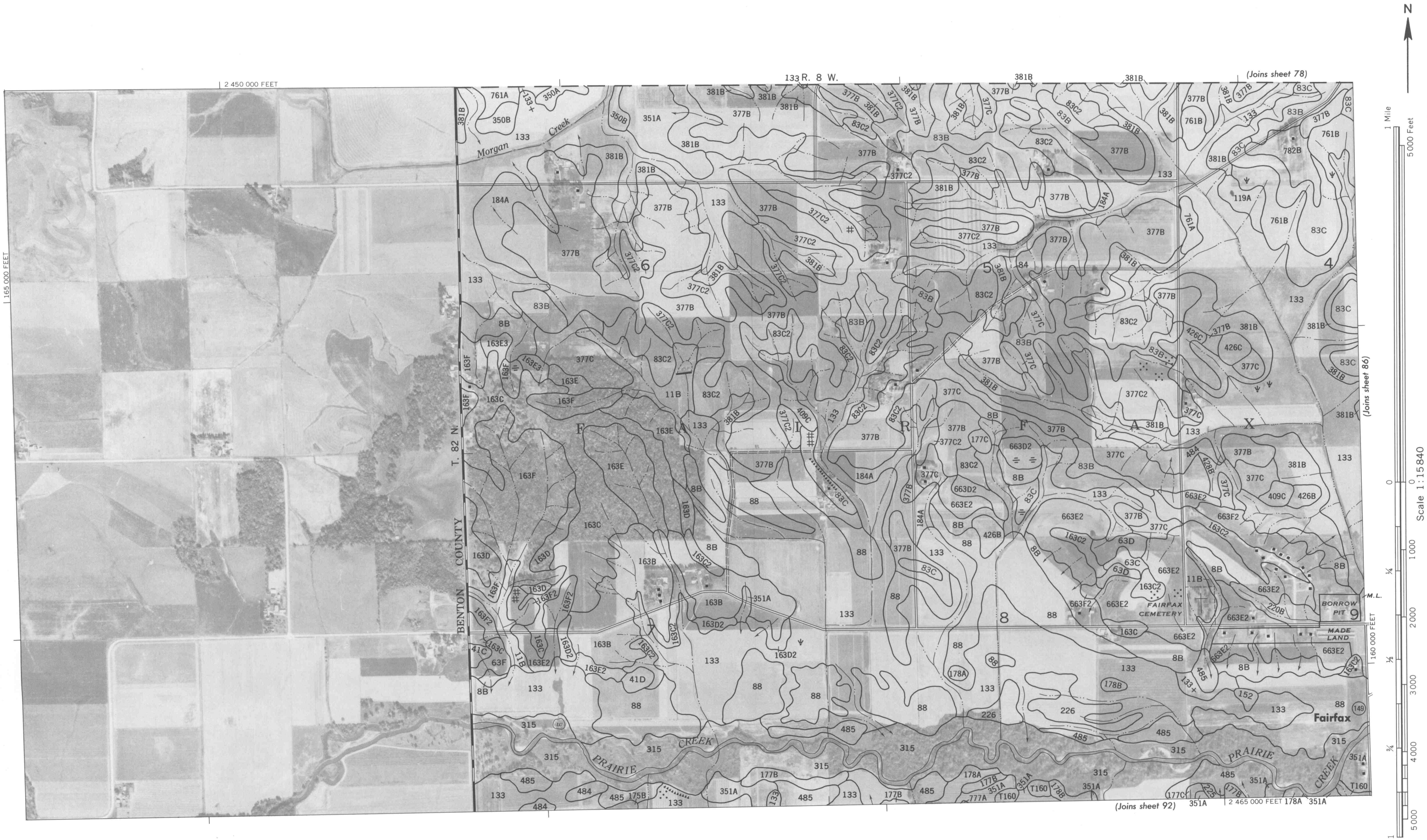

N
(Joins sheet 73)
R. 7 W.
2 505 000 FEET
Filmore School
Roosevelt School
Municipal Island
OAK HILL CEMETERY
SYRIAN CEMETERY
LIMIT OF SOIL SURVEY
CHICAGO AND NORTH WESTERN
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
CHICAGO ROCK ISLAND AND PACIFIC
CEDAR RIVER
RAPIDS
CEDAR RAPIDS
(county seat)
LINWOOD CEMETERY
MADE LAND
(Joins sheet 79)
(Joins sheet 81)
(Joins sheet 87)
175 000 FEET
170 000 FEET
2 490 000 FEET
T. 83 N.
Scale 1:15 840
1 Mile
5 000 Feet
LINN COUNTY, IOWA NO. 80

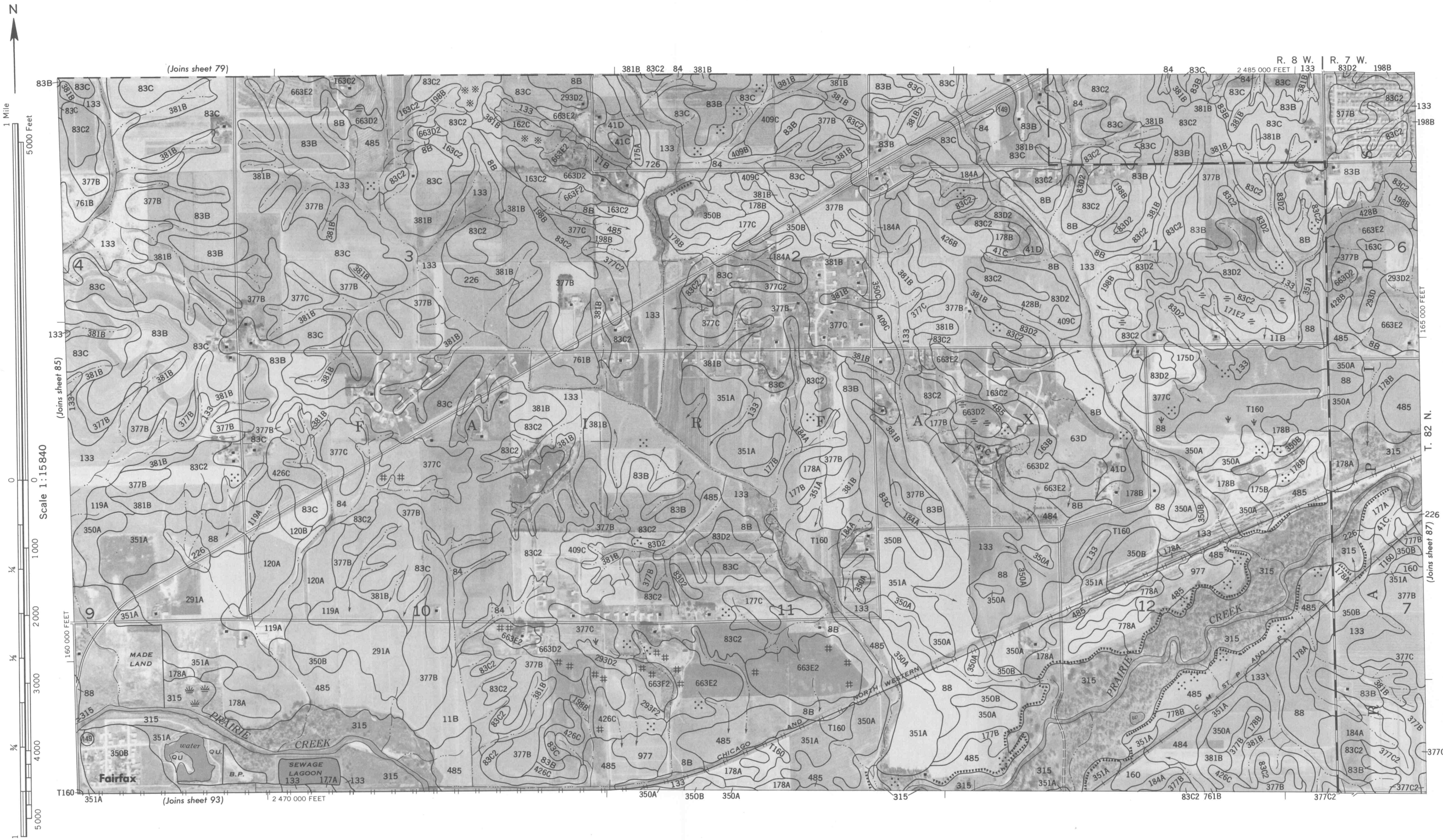

N
R. 7 W. | R. 6 W.
2 510 000 FEET
2 525 000 FEET
175 000 FEET
170 000 FEET
(Joins sheet 74)
(Joins sheet 82)
(Joins sheet 88)
(Joins sheet 80)
CEDAR RAPIDS
(county seat)
Iroquois Park
Vernon View
Squaw Creek
Indian Creek
CEDAR RIVER
CHICAGO AND NORTH WESTERN
INDIAN CREEK SEWAGE DISPOSAL
BORROW PIT
MADE LAND
QUARRY
COLLEGE
26
25
30
29
35
36
31
32
1 Mile
5000 Feet
Scale 1:15840

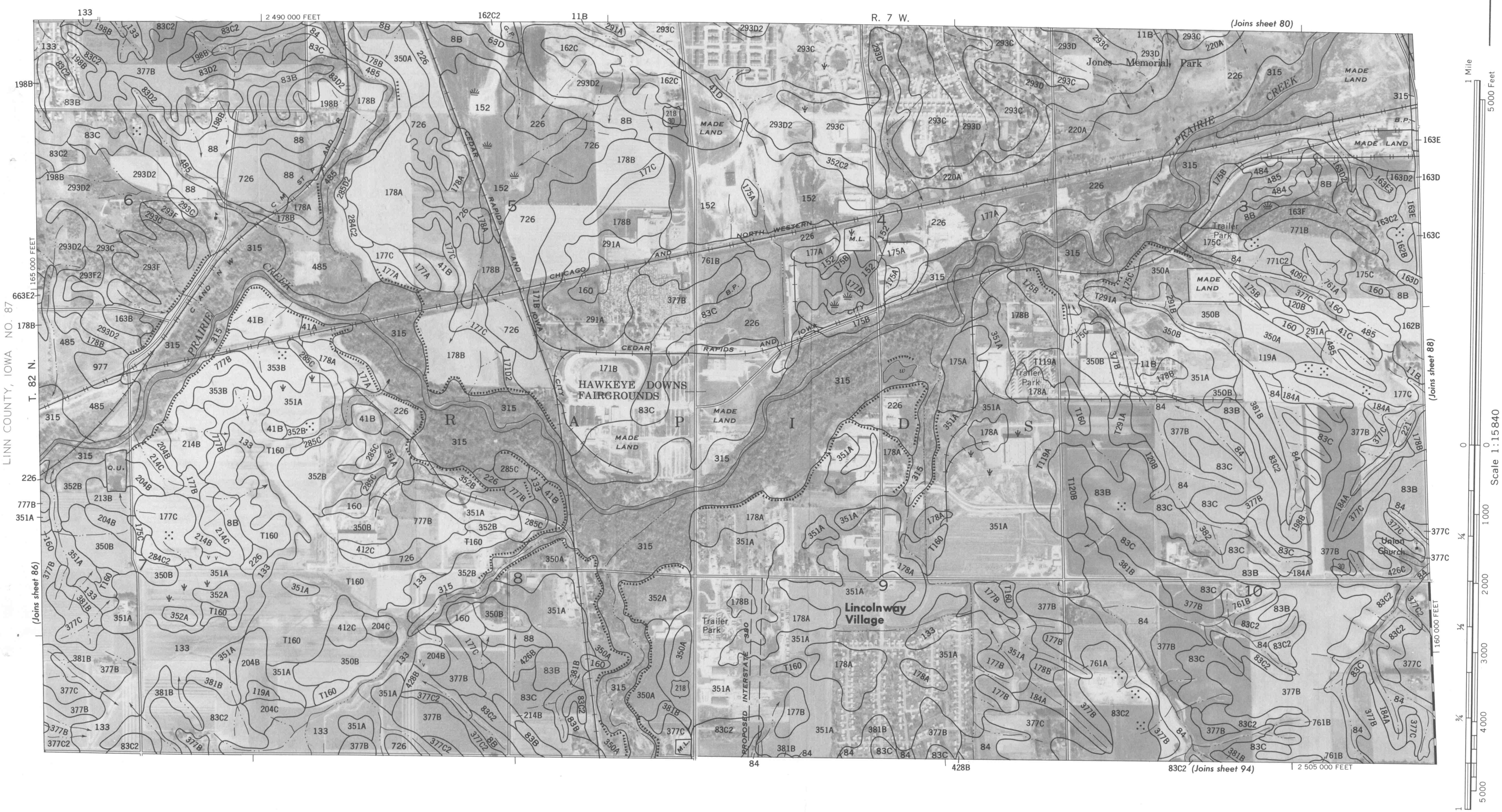

N
1 Mile
5 000 Feet
Scale 1:15840
(Joins sheet 75)
(Joins sheet 81)
(Joins sheet 83)
(Joins sheet 89)
R. 6 W.
T. 83 N.
2 545 000 FEET
2 530 000 FEET
175 000 FEET
170 000 FEET
CAMPBELL CEMETERY
BERTRAM
Bertram
BORROW PIT
MADE LAND
CEDAR RIVER
BIG CREEK
Abby Creek
CHICAGO AND NORTH WESTERN
29
28
27
26
25
32
33
34
35
36


N
R. 6 W.
R. 5 W.
2 550 000 FEET
(Joins sheet 76)
(Joins sheet 84)
(Joins sheet 90)
(Joins sheet 82)
175 000 FEET
170 000 FEET
2 565 000 FEET
T. 83 N.
LINN COUNTY, IOWA NO. 83
25
30
29
28
27
36
31
32
33
34
1 Mile
5000 Feet
Scale 1:15840
0
1000
2000
3000
4000
5000
0
¼
½
¾
1


N
1 Mile
5 000 Feet
Scale 1:15 840
(Joins sheet 77)
(Joins sheet 83)
(Joins sheet 91)
R. 5 W.
T. 83 N.
L I N N
JONES COUNTY
Abby Creek
27
26
25
34
35
36
2 585 000 FEET
180 000 FEET
2 570 000 FEET
170 000 FEET

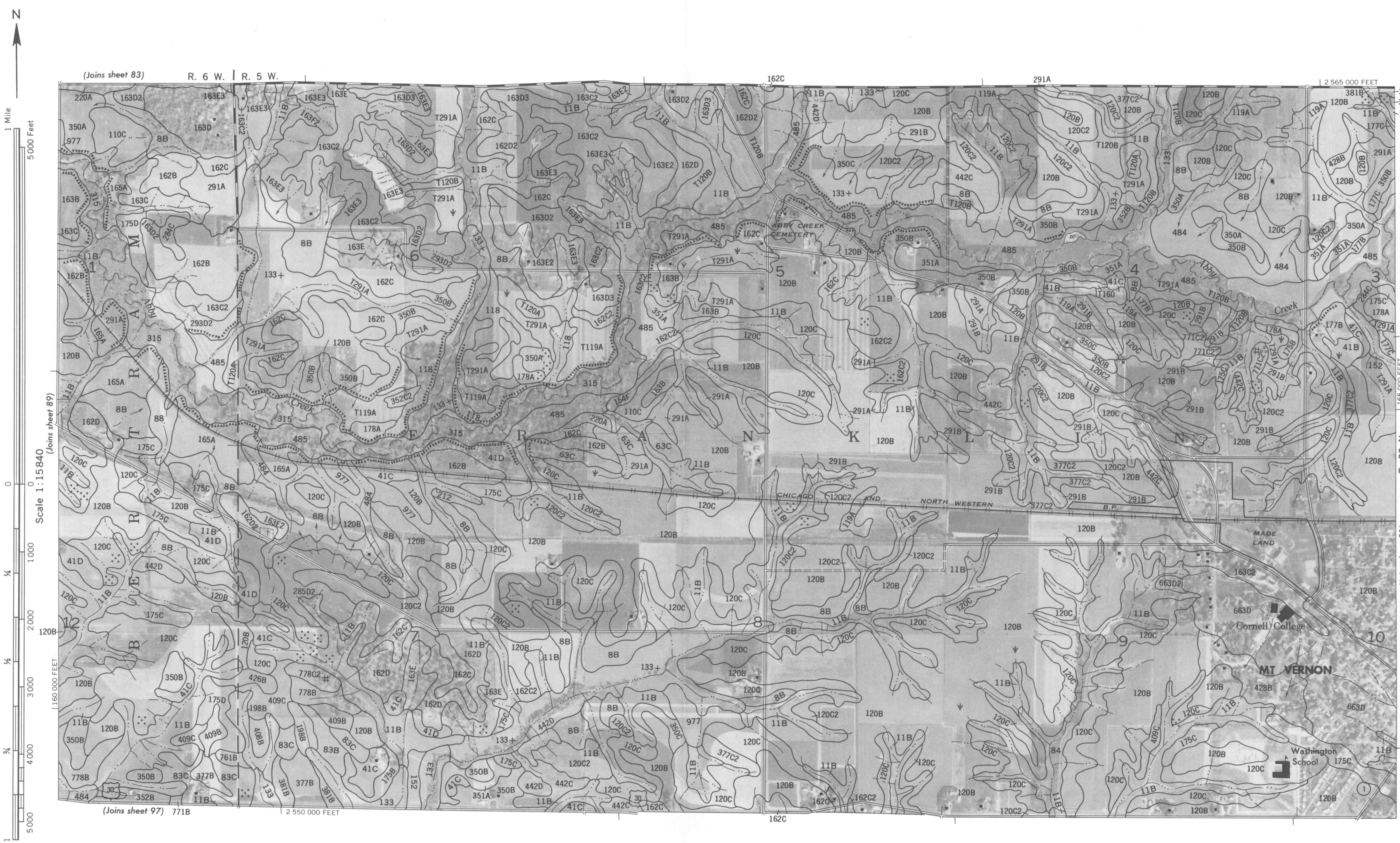

N
R. 8 W.
T. 82 N.
(Joins sheet 78)
(Joins sheet 86)
(Joins sheet 92)
2 450 000 FEET
165 000 FEET
160 000 FEET
2 465 000 FEET
BENTON COUNTY
Morgan Creek
PRAIRIE CREEK
PRAIRIE CREEK
FAIRFAX
FAIRFAX CEMETERY
BORROW PIT
MADE LAND
M.L.
Fairfax
Scale 1:15840
1 Mile
5000 Feet


N
1 Mile
5000 Feet
Scale 1:15840
(Joins sheet 79)
(Joins sheet 85)
(Joins sheet 87)
(Joins sheet 93)
R. 8 W.
R. 7 W.
T. 82 N.
2 485 000 FEET
2 470 000 FEET
165 000 FEET
160 000 FEET
F A I R F A X
PRAIRIE CREEK
CHICAGO AND NORTH WESTERN
C. M. ST. P. AND P.
Fairfax
MADE LAND
SEWAGE LAGOON
water
B.P.
149
LINN COUNTY, IOWA NO. 86


87
N
R. 7 W.
T. 82 N.
(Joins sheet 80)
(Joins sheet 88)
(Joins sheet 94)
(Joins sheet 86)
2 490 000 FEET
2 505 000 FEET
165 000 FEET
160 000 FEET
Jones Memorial Park
HAWKEYE DOWNS FAIRGROUNDS
Lincolnway Village
Union Church
Trailer Park
MADE LAND
PRAIRIE CREEK
CHICAGO AND NORTH WESTERN
CEDAR RAPIDS AND IOWA CITY
C. M. ST. P. AND P.
C AND N W
PROPOSED INTERSTATE 380
R A P I D S
LINN COUNTY, IOWA NO. 87
1 Mile
5000 Feet
Scale 1:15840


N
1 Mile
5000 Feet
Scale 1:15 840
(Joins sheet 81)
(Joins sheet 87)
(Joins sheet 89)
(Joins sheet 95)
R. 7 W. | R. 6 W.
T. 82 N.
2 525 000 FEET
2 510 000 FEET
165 000 FEET
160 000 FEET
CEDAR RIVER
CHICAGO AND NORTH WESTERN
CHICAGO ROCK ISLAND AND PACIFIC
BERTRAM
QUARRY
BAKER CEMETERY
Worthington Acres
PUTNAM
COLLEGE
FAIRFAX
Pleasant Run
LINN COUNTY, IOWA NO. 88


N
R. 6 W.
T. 82 N.
2 530 000 FEET
2 545 000 FEET
165 000 FEET
160 000 FEET
(Joins sheet 82)
(Joins sheet 88)
(Joins sheet 90)
(Joins sheet 96)
BIG CREEK
Abby Creek
CHICAGO AND NORTH WESTERN
CEDAR RIVER
B E R T R A M
P U T N A M
QUARRY
BORROW PIT
MADE LAND
M.L.
B.P.
water
MOORE-SKILLMAN CEMETERY
MADE LAND
LIMESTONE QUARRY
1 Mile
5000 Feet
Scale 1:15840
0
1000
2000
3000
4000
5000



Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

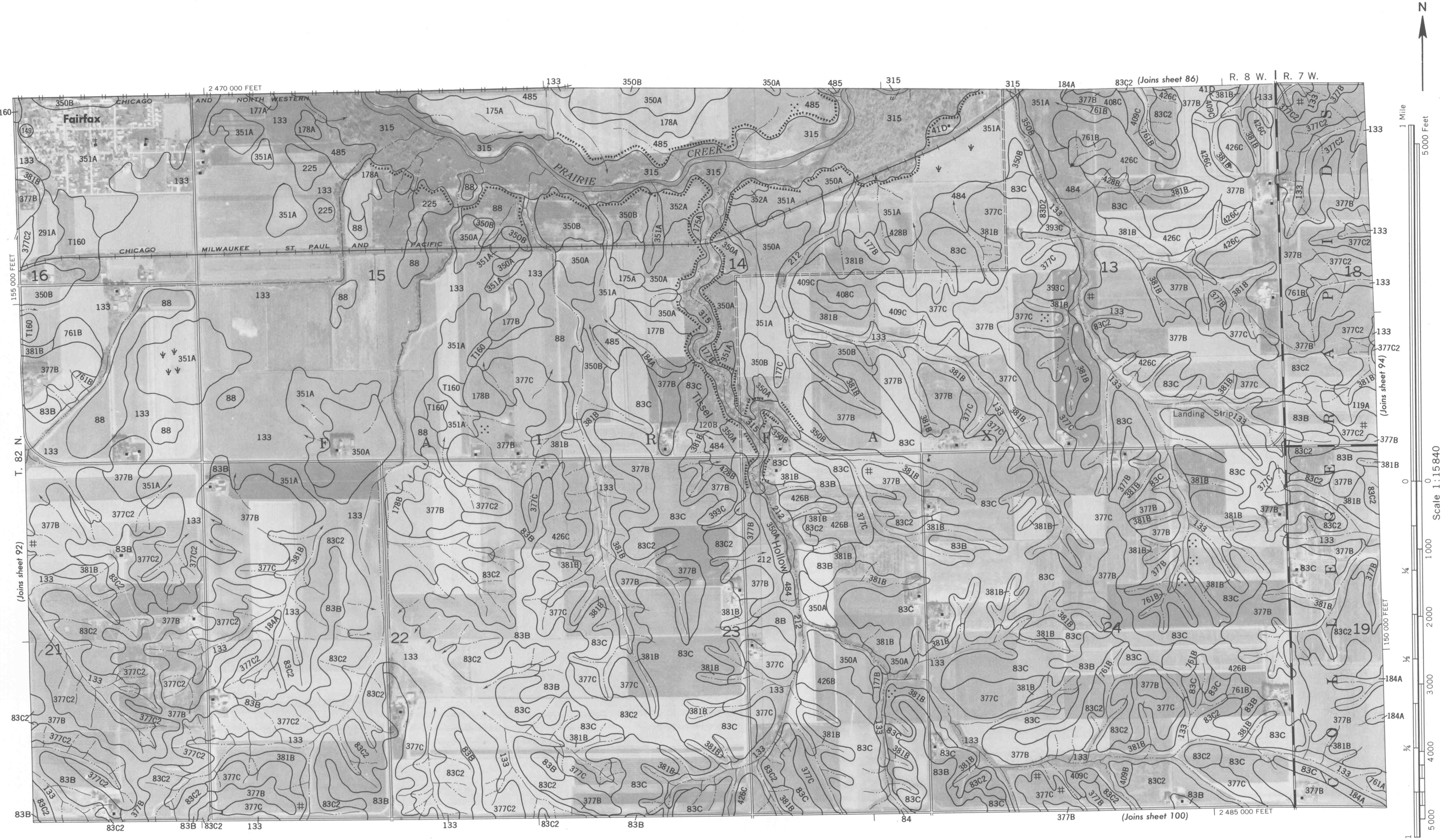
LINN COUNTY, IOWA NO. 91

This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

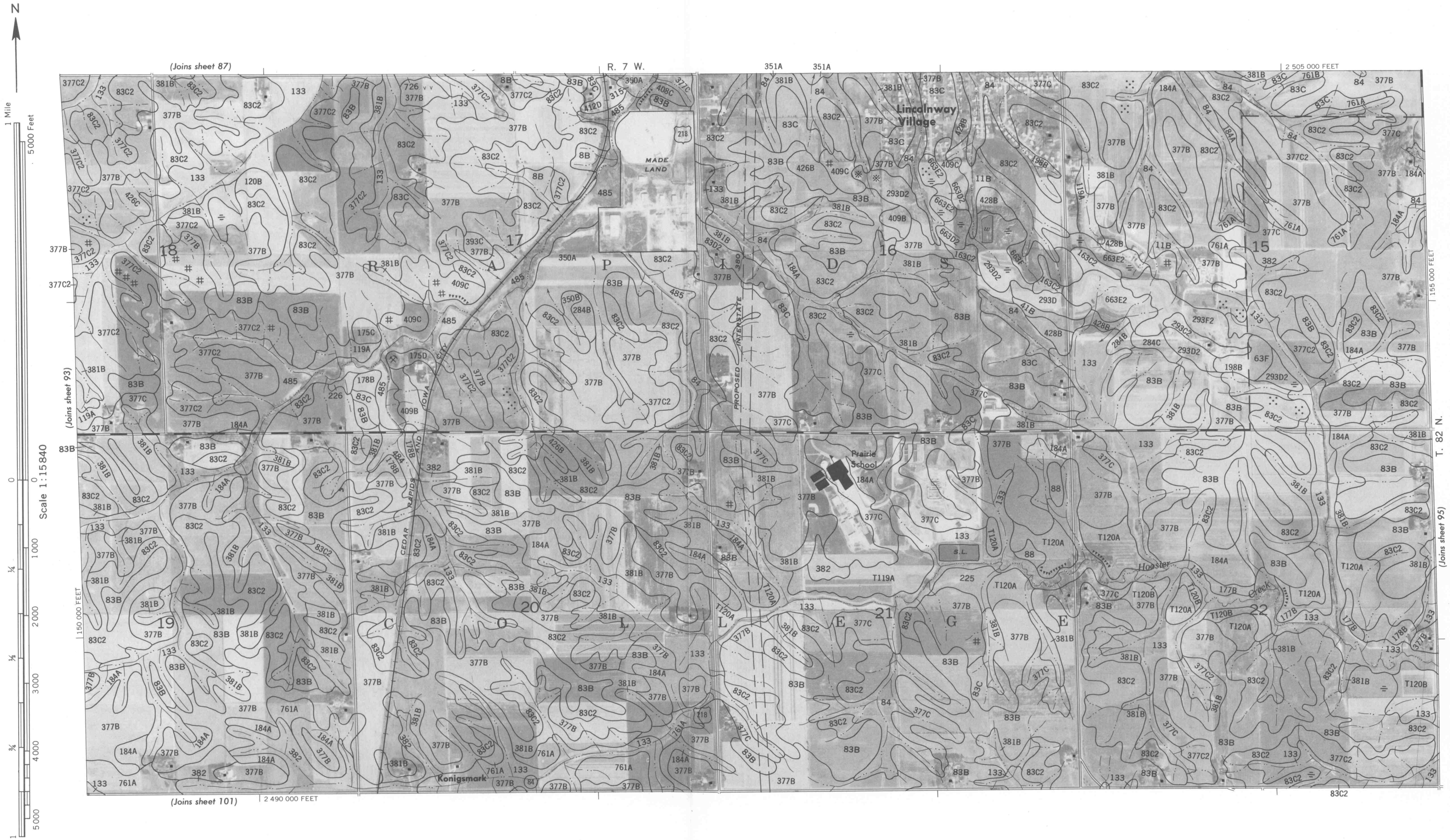
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.

Land division corners are approximately positioned on this map.

LINN COUNTY, IOWA — SHEET NUMBER 92

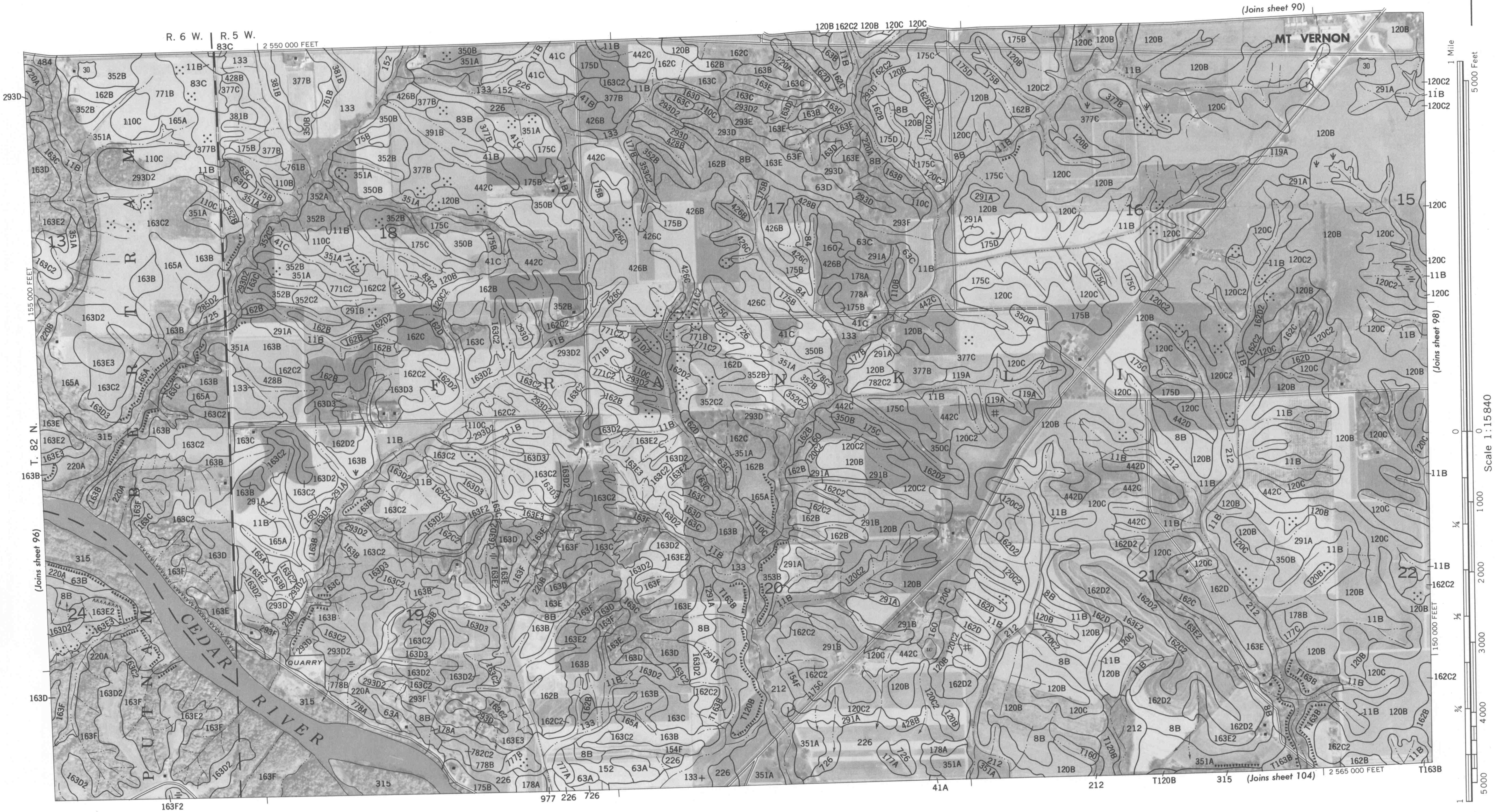

N
(Joins sheet 86)
R. 8 W.
R. 7 W.
2 470 000 FEET
CHICAGO AND NORTH WESTERN
Fairfax
T160
CHICAGO MILWAUKEE ST. PAUL AND PACIFIC
PRAIRIE CREEK
Tissel
Hollow
Landing Strip
FAIRFAX
CEDAR RAPIDS
16
15
14
13
18
21
22
23
24
19
T. 82 N.
155 000 FEET
150 000 FEET
(Joins sheet 92)
(Joins sheet 94)
(Joins sheet 100)
2 485 000 FEET
1 Mile
5000 Feet
Scale 1:15840

LINN COUNTY, IOWA — SHEET NUMBER 94




N
R. 7 W.
R. 6 W.
T. 82 N.
2 510 000 FEET
2 525 000 FEET
155 000 FEET
150 000 FEET
(Joins sheet 88)
(Joins sheet 94)
(Joins sheet 96)
(Joins sheet 102)
COLLEGE
PUTNAM
Pleasant Run
Hoosier Creek
CHICAGO ROCK ISLAND AND PACIFIC
14
13
18
17
23
24
19
20
Scale 1:15840
1 Mile
5000 Feet


N
Scale 1:15840
1 Mile
5000 Feet
(Joins sheet 89)
R. 6 W.
2 545 000 FEET
LIMESTONE QUARRY
MADE LAND
(Joins sheet 95)
150 000 FEET
155 000 FEET
T. 82 N.
ROGERS GROVE CEMETERY
PALISADES - KEPLER STATE PARK
CEDAR RIVER
P U T N A M
B E R T R A M
(Joins sheet 103)
2 530 000 FEET
17
16
15
14
13
20
21
22
23
24

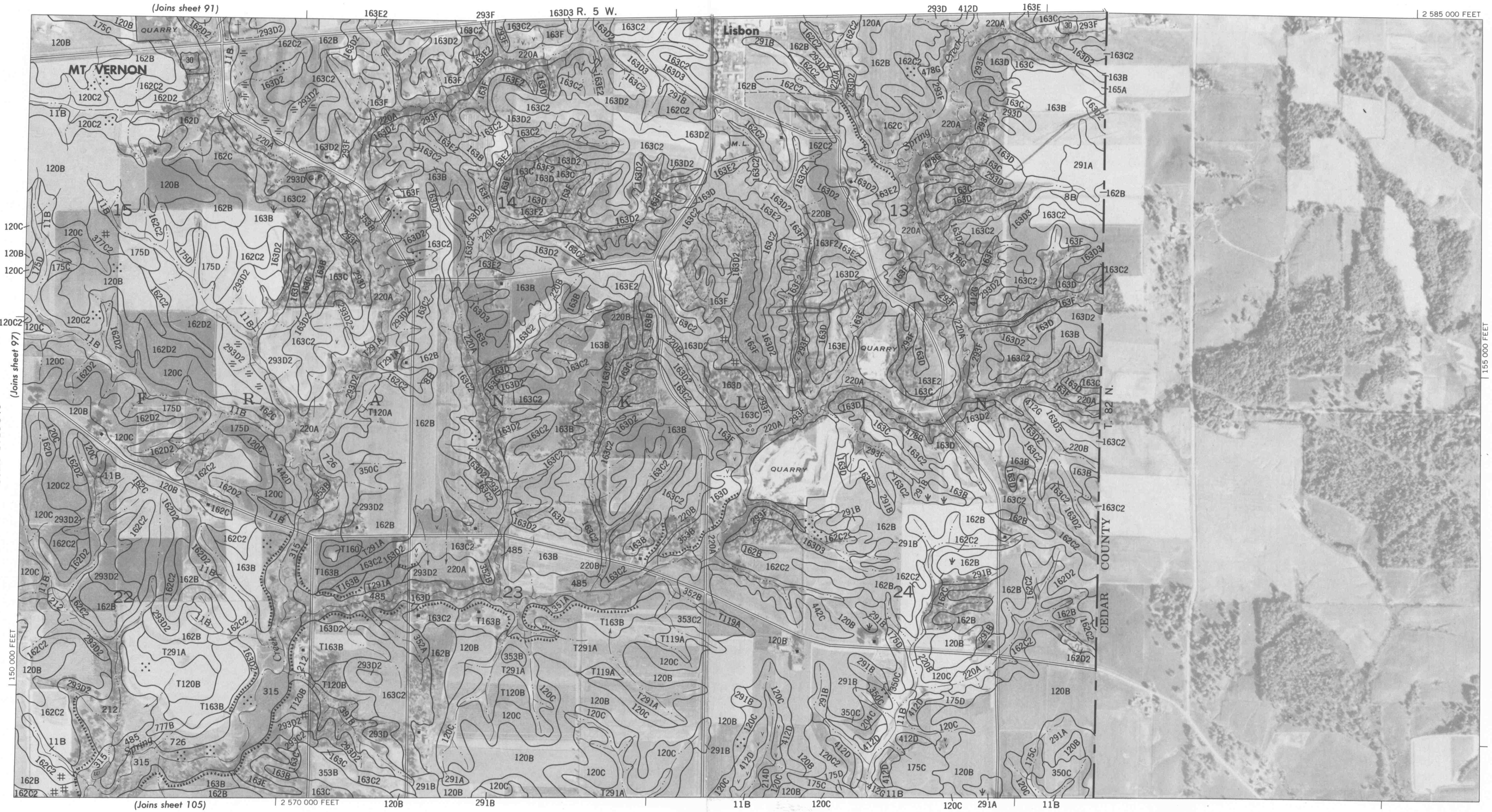

N
R. 6 W.
R. 5 W.
2 550 000 FEET
(Joins sheet 90)
MT VERNON
(Joins sheet 98)
(Joins sheet 96)
(Joins sheet 104)
2 565 000 FEET
155 000 FEET
150 000 FEET
T. 82 N.
CEDAR RIVER
QUARRY
F R A N K L I N
B E R T R A M
P U T N A M
Scale 1:15 840
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1

LINN COUNTY, IOWA — SHEET NUMBER 98

N

1 Mile
5000 Feet

Scale 1:15 840



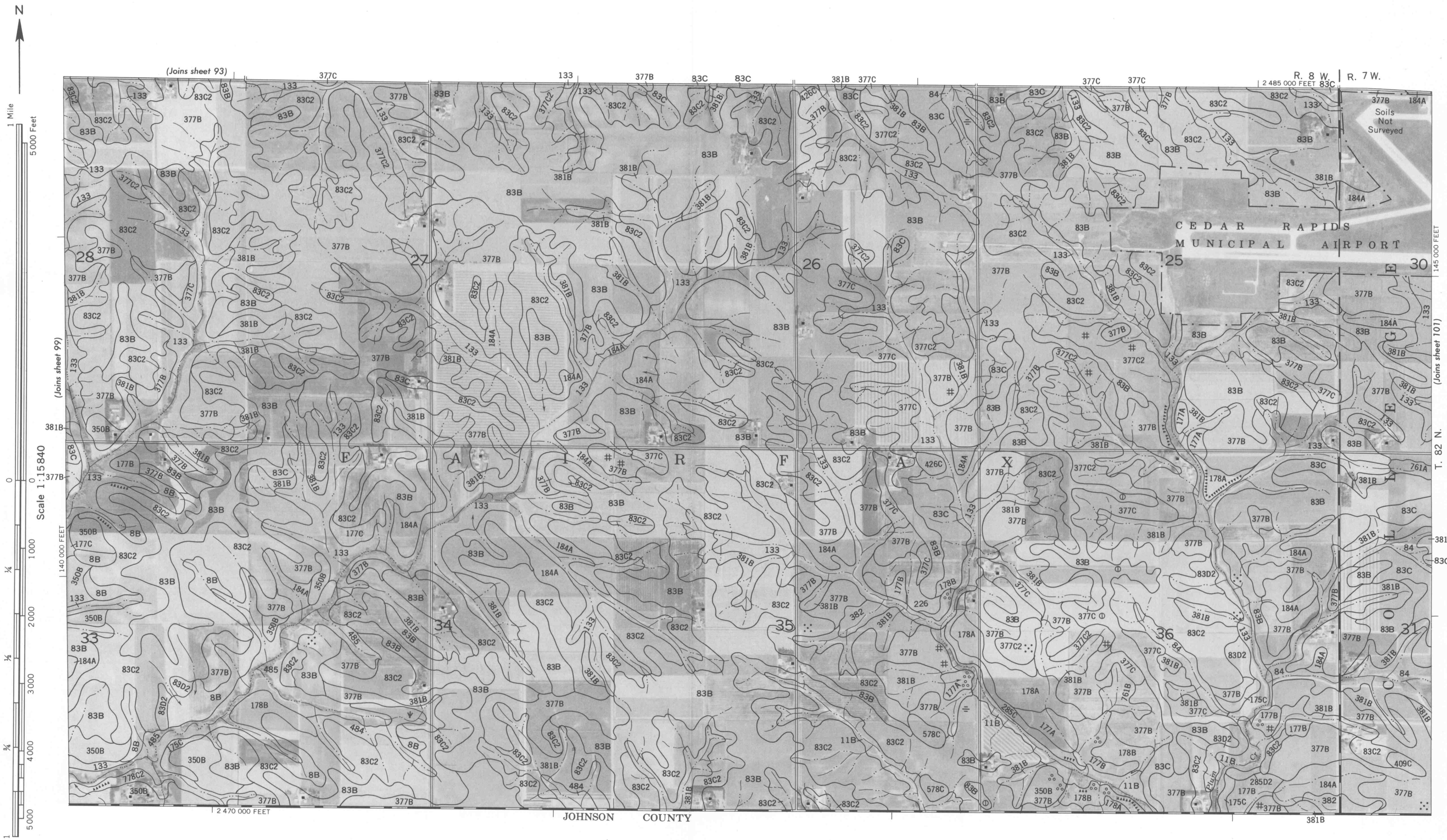
Land division corners are approximately positioned on this map.

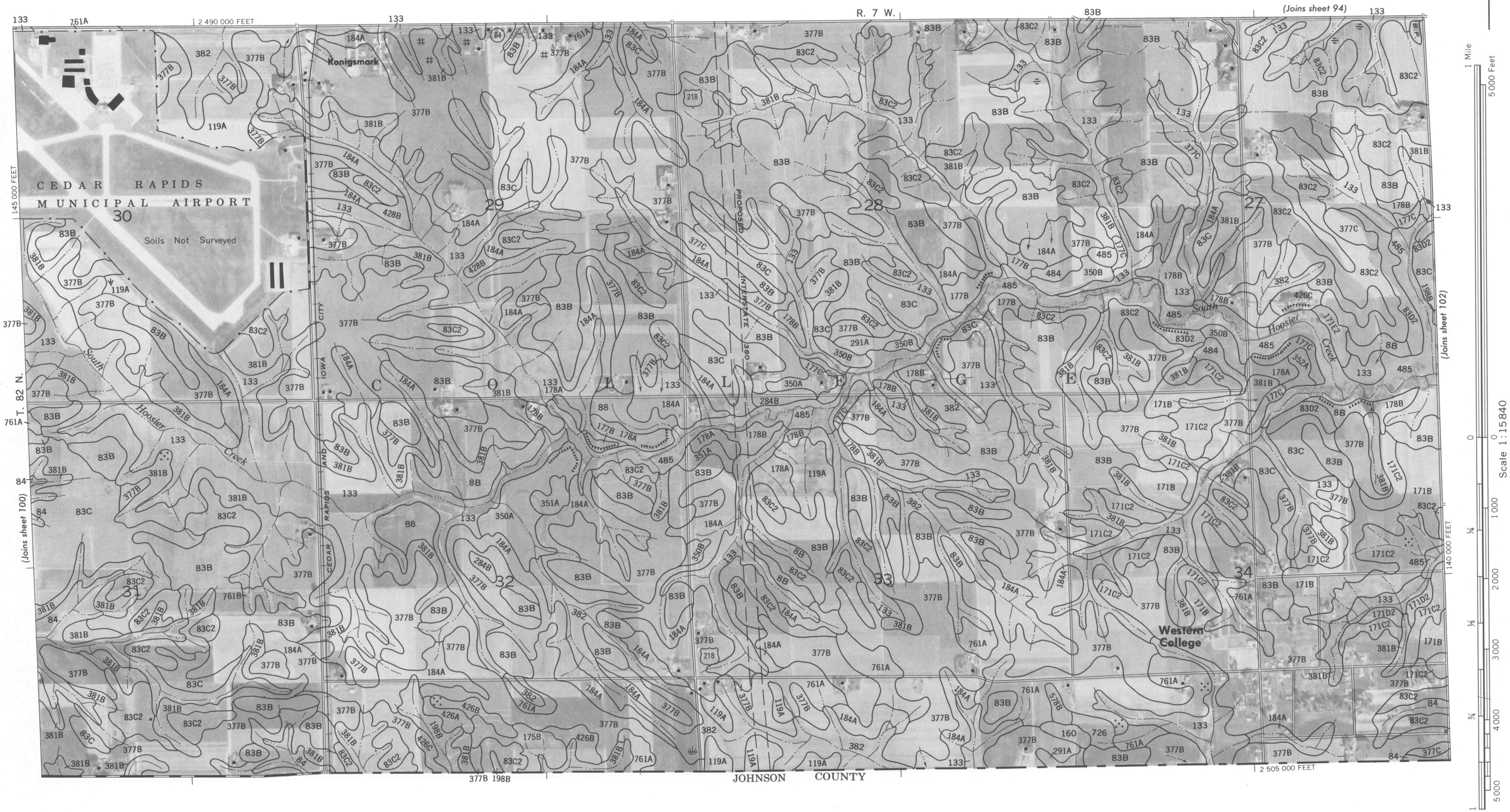
Photobase from 1970 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Iowa coordinate system, north zone.

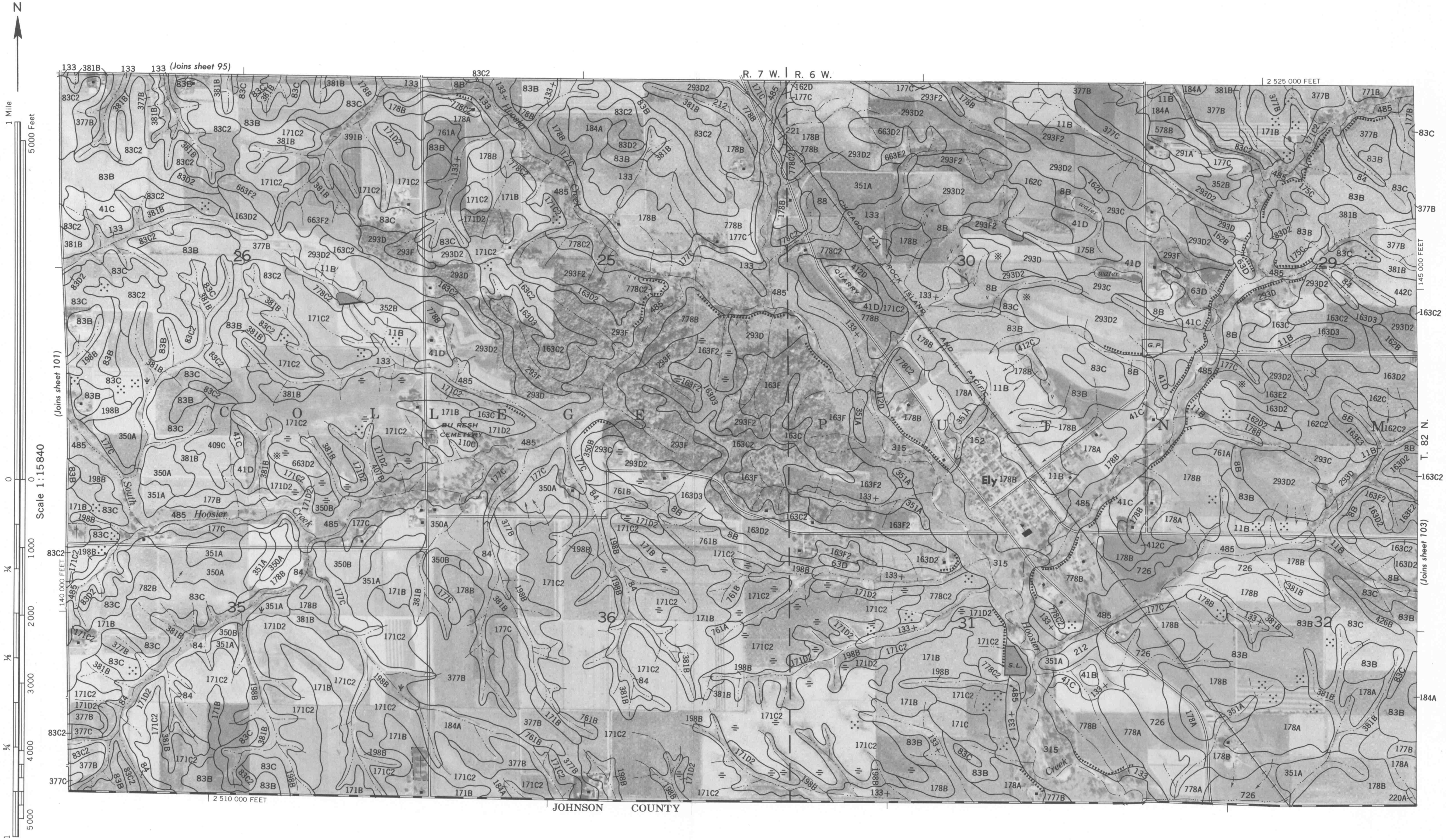
This map is one of a set compiled in 1973 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, Iowa Agriculture and Home Economics Experiment Station, Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa.

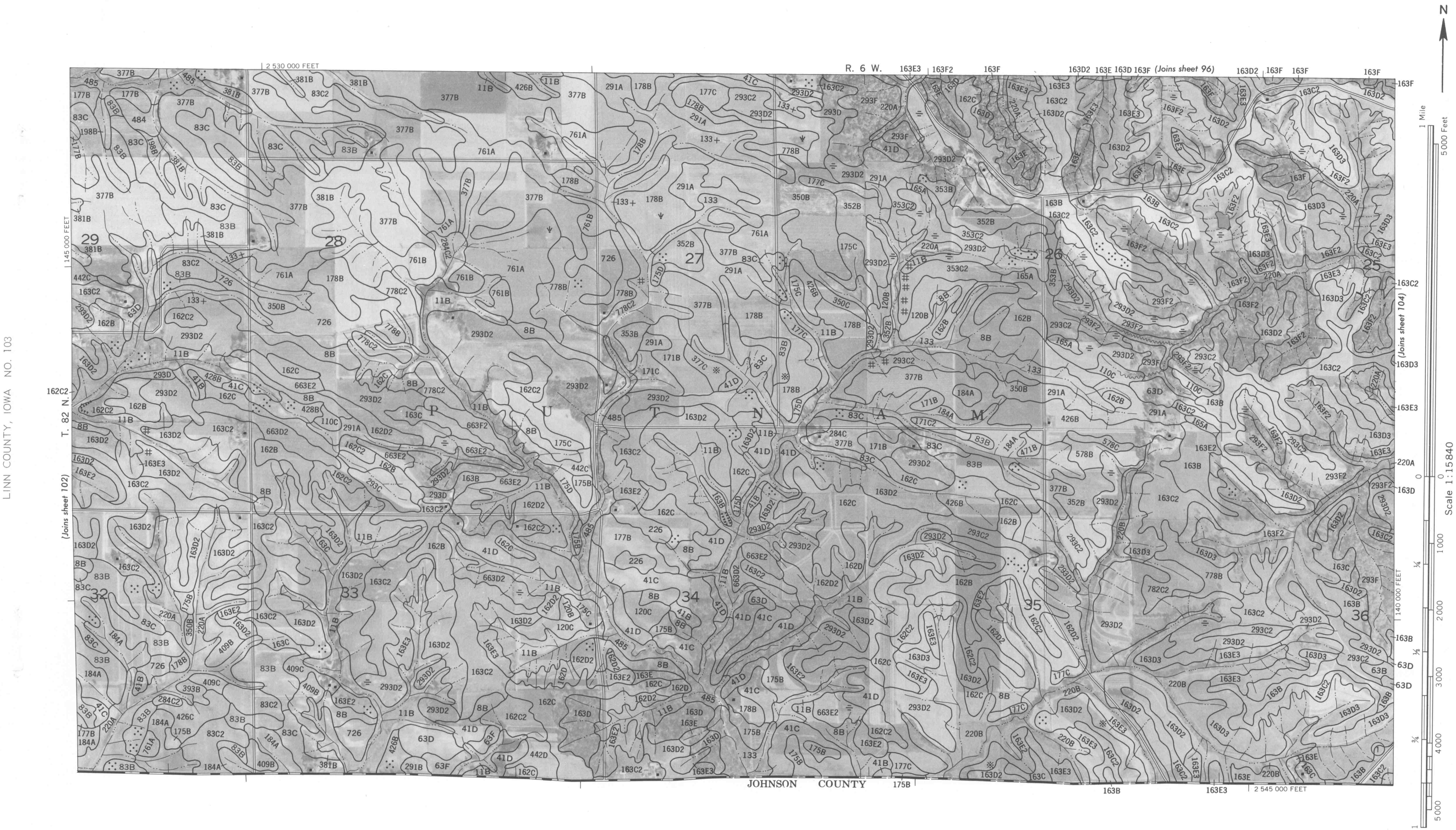
LINN COUNTY, IOWA NO. 98

N
2 450 000 FEET
R. 8 W.
(Joins sheet 92)
145 000 FEET
T. 82 N.
BENTON COUNTY
JOHNSON COUNTY
(Joins sheet 100)
Walford
F A I R F A X
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
Knapp
30
29
28
31
32
33
140 000 FEET
2 465 000 FEET
1 Mile
5 000 Feet
Scale 1:15 840


N
1 Mile
5000 Feet
Scale 1:15 840
(Joins sheet 93)
(Joins sheet 99)
(Joins sheet 101)
R. 8 W.
R. 7 W.
T. 82 N.
2 485 000 FEET
2 470 000 FEET
145 000 FEET
140 000 FEET
Soils Not Surveyed
CEDAR RAPIDS MUNICIPAL AIRPORT
F A I R F A X
C O L L E G E
28
27
26
25
30
33
34
35
36
31
JOHNSON COUNTY
Plum


N
R. 7 W.
(Joins sheet 94)
(Joins sheet 100)
(Joins sheet 102)
T. 82 N.
2 490 000 FEET
2 505 000 FEET
145 000 FEET
140 000 FEET
CEDAR RAPIDS
MUNICIPAL AIRPORT
Soils Not Surveyed
Konigsmark
COLLEGE
South Hoosier Creek
CEDAR RAPIDS AND IOWA CITY
PROPOSED INTERSTATE 380
Western College
JOHNSON COUNTY
29
28
27
30
31
32
33
34
1 Mile
5000 Feet
Scale 1:15 840
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
Scale 1:15840
1 Mile
5000 Feet
(Joins sheet 95)
(Joins sheet 101)
(Joins sheet 103)
R. 7 W. | R. 6 W.
T. 82 N.
2 525 000 FEET
2 510 000 FEET
145 000 FEET
140 000 FEET
JOHNSON COUNTY
C O L L E G E
P U T N A M
Ely
BU RESH CEMETERY
South Hoosier Creek
Hoosier Creek
CHICAGO ROCK ISLAND AND PACIFIC
QUARRY
G.P.
S.L.
26
25
30
29
35
36
31
32


N
2 530 000 FEET
R. 6 W.
(Joins sheet 96)
145 000 FEET
T. 82 N.
(Joins sheet 102)
(Joins sheet 104)
P U T N A M
29
28
27
26
25
32
33
34
35
36
140 000 FEET
JOHNSON COUNTY
2 545 000 FEET
1 Mile
5000 Feet
Scale 1:15840
LINN COUNTY, IOWA NO. 103


N
R. 6 W.
R. 5 W.
(Joins sheet 97)
(Joins sheet 103)
(Joins sheet 105)
T. 82 N.
CEDAR RIVER
FRANKLIN
JOHNSON COUNTY
Spring Creek
Ski Lift
2 565 000 FEET
2 550 000 FEET
145 000 FEET
140 000 FEET
Scale 1:15 840
1 Mile
5 000 Feet

105
N
R. 5 W.
(Joins sheet 98)
(Joins sheet 104)
2 570 000 FEET
2 585 000 FEET
145 000 FEET
140 000 FEET
T. 82 N.
F R A N K L I N
27
26
25
34
35
36
CEDAR RIVER
Spring Creek
CEDAR COUNTY
JOHNSON COUNTY
Scale 1:15840
1 Mile
5000 Feet